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MARCH 1979

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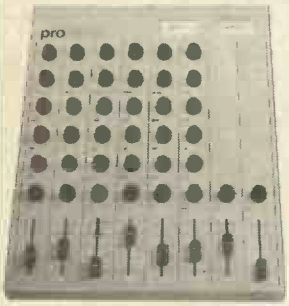

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PRACTICAL
ELECTRONICS

VOLUME 15 No. 3 MARCH 1979

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR APRIL ISSUE WILL BE ON SALE FRIDAY, 9 MARCH 1979
(for details of contents see page 65)

kontite remote control switch

—Simple to install
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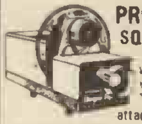

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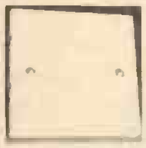

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7416	27p
7417	27p
7420	17p
7421	40p
7422	22p
7423	34p
7425	30p
7426	40p
7427	34p
7428	36p
7430	17p
7432	30p
7433	40p
7437	35p
7438	35p
7440	17p
7441	70p
7442A	60p
7443	112p
7444	112p
7445	100p
7446A	93p
7447A	60p
7448	80p
7450	17p
7451	17p
7453	17p
7454	17p
7460	17p
7470	36p
7472	30p
7473	34p
7474	30p
7475	36p
7476	35p
7480	50p
7481	100p
7482	84p
7483A	90p
7484	100p
7485	110p
7486	34p
7489	210p
7490A	33p
7491	80p
7492A	48p
7493A	33p
7494	84p
7495A	70p
7496	65p
7497	180p
74100	130p
74104	65p
74105	65p
74107	34p
74109	55p
74110	55p
74111	70p
74116	200p
74118	130p
74119	210p
74120	110p
74121	28p
74122	48p
74123	55p
74125	55p
74126	60p
74128	75p
74132	75p
74136	75p
74141	70p
74142	200p
74145	90p
74147	190p
74148	150p
74150	100p
74151A	70p
74153	70p
74154	100p
74155	90p
74156	90p
74157	70p
74159	190p
74160	100p
74161	100p
74162	100p
74163	100p
74164	120p
74165	130p
74166	140p
74167	200p
74170	240p
74172	720p
74173	120p
74174	93p
74175	85p
74176	90p
74177	90p
74178	160p
74180	93p
74181	200p
74182	90p
74184A	150p
74185	150p
74186	700p
74190	100p
74191	100p
74192	100p
74193	100p
74194	100p
74195	95p
74196	95p
74197	80p
74198	150p
74199	150p
74200	1000p
74221	160p
74C221	150p
74251	140p
74259	250p
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74278	290p
74279	140p
74283	190p
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74LS123	70p
74LS124	180p
74LS132	95p
74LS133	60p
74LS138	60p
74LS139	60p
74LS151	100p
74LS153	60p
74LS157	60p
74LS158	120p
74LS160	130p
74LS161	100p
74LS162	140p
74LS163	110p
74LS164	120p
74LS165	180p
74LS166	180p
74LS173	110p
74LS174	90p
74LS175	110p
74LS181	320p
74LS190	100p
74LS191	100p
74LS192	140p
74LS193	140p
74LS195	140p
74LS196	120p
74LS221	140p
74LS240	175p
74LS241	175p
74LS242	170p
74LS243	170p
74LS244	170p
74LS245	170p
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4015	84p
4016	45p
4017	80p
4018	89p
4019	45p
4020	100p
4021	110p
4022	100p
4023	22p
4024	50
4025	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4033	180p
4034	200p
4035	110p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	55p
4049	32p
4050	49p
4051	80p
4052	80p
4053	80p
4054	150p
s4055	125p
4056	135p
4059	600p
4060	115p
4063	120p
4066	55p
4067	450p
4068	22p
4069	20p
4070	30p
4071	22p
4072	22p
4073	22p
4075	22p
4076	107p
4081	22p
4082	22p
4093	80p
4094	250p
4098	107p
4411	1100p
4502	120p
4503	70p
4507	55p
4510	99p
4511	150p
4514	250p
4516	110p
4518	100p
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LM324	70p
LM339	75p
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LM741	20p
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LM3911	130p
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MK50398	750p
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*BC172	12p
BC177/8	17p
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*BC182/3	10p
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*BC214	12p
BC461	36p
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*BC516/7	30p
*BC547B	16p
*BC549C	18p
*BC557B	16p
*BC559C	18p
BCY70	18p
BCY71/2	22p
BD131/2	50p
BD135/6	54p
BD139	56p
BD140	60p
BD189	60p
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BDY56	200p
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*BF256B	70p
BF257/8	32p
BF259	36p
*BFR39	30p
*BFR40	30p
*BFR41	30p
*BFR79	30p
*BFR80	30p
*BFR81	30p
BFX29	30p
BFX30	34p
BFX84/5	30p
BFX86/7	30p
BFX88	30p
BFW10	90p
BFY50	22p
BFY51/2	22p
BFY56	33p
BFY90	90p
BLY83	700p
BRY39	45p
BSX19/20	20p
BU104	225p
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OC35	130p
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*R20108	200p
*TIP29A	40p
*TIP29C	55p
*TIP30A	48p
*TIP30C	60p
*TIP31A	58p
TIP31C	62p
TIP32A	68p
TIP32C	82p
TIP33A	90p
TIP33C	114p
TIP34A	115p
TIP34C	160p
TIP35A	225p
TIP35C	290p
TIP36A	270p
TIP36C	340p
TIP41A	65p
TIP41C	78p
TIP42A	70p
TIP42C	82p
TIP2955	78p
TIP4055	70p
*TIS43	34p
*TIS93	30p
*ZTX108	12p
*ZTX300	13p
ZTX500	15p
*ZTX502	18p
*ZTX504	30p
2N457A	250p
2N696	35p
2N697	25p
2N698	45p
2N706A	20p
2N708A	20p
2N918	45p
2N940	18p
2N1131/2	20p
2N1613	25p
N1711	25p
2N2102	60p
2N2160	300p
2N2219A	22p
2N2222A	22p
2N2369A	16p
2N2484	30p
2N2646	50p
2N2904/5	25p
2N2906A	24p
2N2907A	30p
*2N2926	9p
2N3053	20p
2N3054	65p
2N3055	48p
2N3442	140p
2N3553	240p
*2N3565	30p
*2N3643/4	48p
*2N3663	20p
*2N3702/3	12p
*2N3704/5	12p
*2N3706/7	14p
*2N3708/9	12p
*2N3773	300p
*2N3819	25p
*2N3820	50p
2N3823	70p
2N3866	90p
*2N3903/4	18p
*2N3905/6	20p
2N4037	65p
2N4058/9	12p
*2N4060	12p
*2N4061/2	18p
*2N4123/4	22p
*2N4125/6	22p
*2N4289	20p
*2N4401/3	27p
2N4427	90p
*2N4871	60p
*2N5087	27p
*2N5089	27p
*2N5172	27p
2N5179	90p
2N5191	83p
2N5194	90p
*2N5245	40p
*2N5296	55p
*2N5401	50p
*2N5457/8	40p
*2N5459	40p
*2N5460	40p
2N5485	44p
*2N6027	48p
2N6247	190p
2N6254	130p
2N6290	65p
2N6292	65p
3N128	120p
3N140	100p
3N141	110p
3N201	110p
3N204	100p
40290	250p
40360	40p
40361/2	45p
40364	120p
40408	70p
40409	85p
40410	85p
40411	300p
40594	97p
40595	105p
40673	75p
40841	90p
40871/2	90p

DIODES

*BY127	12p
*OA47	9p
*OA81	15p
*OA85	15p
*OA90	9p
*OA91	9p
*OA95	9p
*OA200	9p
*OA202	10p
*1N914	4p
*1N916	7p
*1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
*15920	9p

*ZENEERS

2.7V-33V

400mW	9p
1W	15p

TRIACS PLASTIC

3A 400V	60p
3A 500V	65p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

HEAT SINKS

For TO220 Voltage Regs. and Transistors	22p
For TO5	12p

BRIDGE RECTIFIERS

*1A 50V	21p
*1A 100V	22p
*1A 400V	30p
*1A 600V	35p
*2A 50V	30p
*2A 100V	35p
*2A 400V	45p
*3A 200V	60p
*3A 600V	72p
*4A 100V	95p
*4A 400V	100p
6A 50V	90p
6A 100V	100p
6A 400V	120p
10A 400V	200p
25A 400V	400p

THYRISTORS

1A 50V	40p
1A 400V	65p
1A 600V	70p
3A 400V	90p
8A 600V	140p
12A 400V	160p
16A 100V	160p
16A 400V	180p
16A 600V	220p
BT106	110p
C106D	45p
*MCR101	36p
2N3525	120p
2N4444	140p
*2N5060	34p
*2N5064	40p

LOUDSPEAKERS

Size		
2¼"	64R	70p
2½"	8R	70p
2"	8R	75p
1½"	8R	75p

VOLTAGE REGULATORS

Fixed Plastic TO-220

1A	+ve		−ve	
5V	7805	90p	7905	100p
12V	7812	90p	7912	100p
15V	7815	90p	7915	100p
18V	7818	90p	7918	100p
24V	7824	90p	7924	100p

100mA	TO-92			
5V	78L05	35p	79L05	80p
12V	78L12	35p	79L12	80p
15V	78L15	35p	79L15	80p

OTHER REGULATORS

LM309K	135p	T8A6258	120p
LM317T	200p	TL430	65p
LM323K	625p	78HO5KC	675p
LM723	37p	778MGT2C	135p

OPTO-ELECTRONICS

2N5777	45p	OCP71	130p
ORP12	90p	ORP60	90p
ORP61	90p	TIL78	70p

LEDS

0.125"		0.2"	
TIL32 I.R.	75p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	MV5491 TS	120p
TIL216 Red	18p	Clips	3p

DISPLAYS

3015F	200p	FND500	120p
DL704	140p	FND507	120p
DL707 Red	140p	MAN3640	175p
707 Gr	140p	TIL311	600p
DL747 Red	225p	TIL312/3	110p
747 Gr	225p	TIL321/2	130p
FND357	120p	TIL330	140p

DRIVERS

9368	200p
9370	200p

MEMORIES

2102	100p
2102-2	120p
2102L-4	140p
2107B	600p
2111-1	225p
2112-2	300p
2114	1000p
5101	510p
6810	350p

ROM/PROMs

74S188	225p
74S287	400p
74S387	400p
93427	400p
93436	650p
93446	650p
93448	1000p

CPUs

4040a	670p
6502	1200p
6800	900p
6801	TBA
8080A	550p

EPROMS

1702A	600p
2708	900p
2716	2500p
4702	900p

UART

AY-3-1015P	500p
AY-5-1013	400p
TMS6011NC	400p

CHARACTER GENERATOR

3257ADC	990p
MCM6576	750p
RO-3-2513 U.C.	600p
RO-3-2513 L.C.	550p
SN74S262AN	1360p

OTHER

3245	400p
4201	390p
4289	970p
4801	500p
6820	600p
6850	700p
8205	320p
8212	225p
8216	225p
8224	400p
8228	525p
8251	700p
8253	1200p
8255	550p
8257	1100p
8259	1400p
AY5-2376	1000p
MC14411	1100p

SUBMINIATURE SWITCHES

Toggle SPST	51p
SPDT	53p
DPDT	55p
DPDT (Centre-off)	85p
Push to make (Red, Green, Yel., Blue)	15p
Push to break (Black only)	25p

CRYSTALS

100KHz	300p
1MHz	370p
3.2768MHz	350p
10.7MHz	350p
18MHz	300p
27.135MHz	300p

EDGEBOARD CONNECTORS

0.156" Solder Tail

2 x 10 way	85p
2 x 15 way	100p
2 x 18 way	120p
2 x 22 way	150p
2 x 25 way	160p

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(prim 220-240V)

6-0-6	100mA	88p
9-0-9	75mA	92p
12-0-12	100mA	95p
0-12 0-12	500mA	280p+
0-25V (5VA)		250p
9-0-9	1A	270p*
12V	2A	350p*
0-12-15		
20-24-30	1A	340p*
15-0-15	1A	265p*

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16 pin	13p	22 pin	30p	40 pin	51p

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8 pin	30p	24 pin	80p
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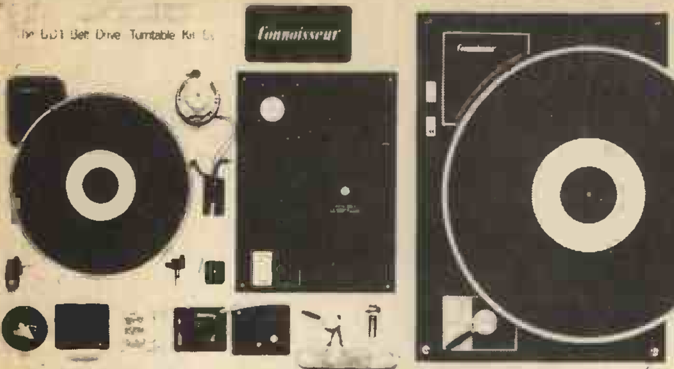

BD1 Kit & Completed BD1 Assembly

BD1 with Plinth, Cover & SME Arm.

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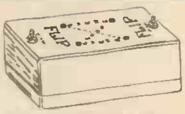

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100μF 350V 8p

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TANTALUM BEAD CAPACITORS
35V: 0.1μF, 0.22, 0.33, 0.47, 0.68, 1.0, 2.2μF, 3.3, 4.7, 6.8; 25V: 1.5, 10; 20V: 1.5; 16V: 10μF **13p** each, 47, 100 40p; 10V: 22μF, 33; 6V: 47, 68, 100; 3V: 68, 100μF **20p** each.

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0.015, 0.02, 0.04, 0.05, 0.056μF 7p
0.01μF, 0.2 9p 50V: 0.47μF 11p

CERAMIC CAPACITORS: 50V
0.5pF to 10nF 3p each
15nF, 22nF, 33nF, 47nF 4p each
0.1μF 6p; 0.2μF 7p

POLYSTYRENE CAPACITORS
10pF to 1nF 8p; 1.5nF to 47nF 10p.

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250, 300, 330, 360, 390, 600, 820 16p each
1000, 1800, 2000, 2200 20p each

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2 5 6pF 3-10pF, 10-40pF 22p
5 25pF 5 45pF, 60pF 88pF 30p

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100 pins 50p; 1000 pins 395p

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5KΩ-2MΩ single gang D/P switch	60p
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0-25W log and linear values 60mm

5KΩ-500KΩ single gang	70p
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Self Stick Graduated Bezels	22p

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Vertical & Horizontal

0 1W 50Ω 5MΩ Miniature	8p
0-25W 100Ω—3-3MΩ Horiz	10p
0-25W 200Ω—4-7MΩ Vert	10p

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2% Metal Film 10Ω-1MΩ		6p	4p
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IC741 (Texas) 17p*
NE555 (Texas) 22p*

OPTO ELECTRONICS★
LEDs plus clip

TIL209 Red	13
TIL211 Grn	17
TIL2 12 Yellow	18
·2" Red	15
2" Yellow Green	18
Spare Clips	2
ORP12	63
2N5777	45
7 Seg Displays	
LS400	255
TIL307	675
TIL312 C An 3"	105
TIL313 C Cth 3"	105
TIL321 C An 5"	115
TIL322 C Cth 5"	115
DI704 C Cth ·3"	99
DL707 C.A. ·3"	99
FND357	120
MAN3640	175
LCD 3½ digit	875

SWITCHES★
TOGGLE 2A 250V

SPST	28p
DPDT	38p
4 pole on/off	54p
SUB-MIN TOGGLE	
SP changeover	59p
SPST on/off	54p
DPDT 6 tags	70p
DPDT Centre off	79p
DPDT Biased	115p
SLIDE 250V:	
1A DPDT	14p
1A DP c/over	15p
½A DPDT	13p
4 pole c/over	24p
PUSH BUTTON	
Spring loaded	
SPST on/off	65p
SPDT c/over	70p
DPDT 6 Tag	85p

	JACK PLUGS		SOCKETS		
	Screened chrome	Plastic body	open metal	moulded with break contacts	in line couplers
2·5mm	13p	10p	8p		11p
3·5mm	15p	10p	8p		12p
MONO	25p	14p	13p	20p	18p
STEREO	32p	18p	15p	24p	22p

DIN	PLUGS	SOCKETS	In Line
2 PIN Loudspeaker	10p	6p	20p
3, 4, 5 Pin Audio	13p	10p	20p
Co-axial (plastic)	10p	12p	12p
(metal)	18p	18p	22p
PHONO		6p single	15p
assorted colours	10p	8p double	—
Metal Screened	15p	15p 4-way	20p
BANANA 4mm	11p	12p	—
2mm	10p	10p	—
1mm	6p	6p	—
WANDER 3mm	6p	6p	

SWITCHES ★ Miniature Non-Locking
Push to Make 15p Push to Break 25p
ROCKER (white) 10A 250V
SP changeover centre off 30p
ROCKER: (black) on/off 10A 250V 23p
ROCKER: Illuminated (white)
Lights when on: 3A 240V 52p
ROTARY: (ADJUSTABLE STOP) 1 pole/2-12 way 2p/2-6W 3p/2-4W 4p/2-3W 41p
ROTARY: Mains 250V AC, 4 Amp 45p

DIL SOCKETS ★ (Low Profile – Texas)
8 pin **10p**; 14 pin **12p**; 16 pin **13p**; 18 pin **20p**; 20 pin **27p**; 24 pin **30p**; 28 pin **42p**; 40 pin **55p**.

DIGITAL MULTIMETER

Announcing DM900 – The Digital Multimeter with a difference – It measures Capacitance too. *(as published in E.T.I. August 1978)*

Throw away your analogue meters, here's digital accuracy at only half the price of an equivalent commercial Multimeter.

The DM900 is a 3½ digit multimeter with an 0.5In L.C.D. display incorporating:

5 AC & DC Voltage ranges; 6 Resistance ranges.
5 AC & DC Current ranges; 4 Capacitance ranges.

The prototype accuracy is better than 1%.

This is a unique design using the latest MOS ICs and due to the minimal current drain, is powered by only one PP3 battery. There is also a battery check facility.

DM900 is an attractive hand-held lightweight device, built into a high impact case with carrying handle and has been ingeniously designed to simplify assembly.

Never before have all these features been offered to the electronics enthusiast in a single unit.

Price: **£54.50*** only (p&p insured add 80p)
Send SAE for leaflet.
Ready Built and tested units **£78.50*** including probes and carrying case (P&P insured 80p)
(Demonstration on at our shop)

PE VDU SYSTEMS

parts now available
(send SAE for list)

Convert your TV into a VDU by using the new Thomson-CSF, TV-CRT controller chip SF.F 96364. 16 lines by 64 characters, text refreshment, cursor management on TV screen, line erasing, line end erasing. Compatible with any computing system.

SFF 96364E	£11.75*
AY-5-1013UART	£4.50*
71301 ROM SFC	£8.20*
SFS80102 RAM 1K	£2.05*
74LS163	£0.95*
MC1488	£0.85*
MC1489	£0.90*
SN75450	£1.20*
SN75451	£0.70*
SN75452	£0.70*
SN75454	£12.40
2102 LF	£1.60*
2513	£5.95*
74LS132	£0.95*
81LS97	£1.09*
1 MHz crystal	£3.23*
14.31818 MHz	£2.70*
UHF Modulator	£2.50*

TTL 74★

7400	13
7401	13
7402	14
7403	14
7404	14
7405	18
7406	38
7407	38
7408	17
7409	17
7410	15
7411	20
7412	17
7413	30
7414	51
7416	30
7417	30
7420	16
7421	29
7422	24
7423	27
7425	27
7426	36
7427	27
7428	35
7430	17
7432	25
7433	40
7437	30
7438	33
7440	17
7441	74
7442	68
7443	115
7444	112
7445	94
7446	94
7447	82
7448	56
7450	17
7451	17
7453	17
7454	17
7460	17
7470	28
7472	25
7473	32
7474	27
7475	38
7476	36
7480	48
7481	86
7482	69
7483	72
7484	95
7485	106
7486	31
7489	210
7490	33
7491	75
7492	38
7493	32
7494	78
7495	65
7496	57
7497	189
74100	119
74105	62
74107	29
74109	54
74110	54
74111	68
74112	125
74116	198
74118	83
74119	149
74120	115
74121	25
74122	46
74123	48
74125	38
74126	57
74128	74
74132	73
74136	73
74141	56
74142	209
74143	314
74144	314
74145	65
74147	175
74148	109
74150	99
74151	64
74153	64
74154	96
74155	53
74156	80
74157	67
74159	185
74160	82
74161	92
74162	92
74163	92
74164	105
74165	105
74166	140
74167	200
74170	185
74172	625
74173	120
74174	87
74175	87
74176	75
74177	78
74178	102
74180	85
74181	165
74182	88
74184	135
74185	135
74188	275
74190	95
74191	95
74192	98
74193	98
74194	98
74195	96
74196	93
74197	80
74198	150
75150	110
75491	75
75492	80

CMOS★

4000	15
4001	15
4002	16
4006	92
4007	18
4008	82
4009	38
4010	38
4011	18
4012	18
4013	45
4014	80
4015	82
4016	45
4017	82
4018	87
4019	48
4020	99
4021	95
4022	85
4023	22
4024	66
4025	19
4026	180
4027	45
4028	81
4029	99
4030	58
4031	205
4032	100
4033	145
4034	116
4035	111
4036	325
4037	100
4038	108
4039	320
4040	105
4041	80
4042	75
4043	94
4044	95
4045	145
4046	128
4047	87
4048	58
4049	48
4050	48
4051	72
4052	72
4053	72
4054	110
4055	128
4056	134
4057	2570
4059	480
4060	115
4061	1425
4062	999
4063	110
4066	58
4067	380
4068	22
4069BE	20
4070	32
4071	21
4072	21
4073	21
4075	23
4076	85
4077	40
4078	21
4081	20
4082	21
4085	74
4086	73
4089	150
4093	85
4094	190
4095	105
4096	105
4097	372
4098	110
4099	145
4160	109
4161	109
4162	109
4163	109
4174	110
4175	99
4194	108
4408	720
4409	720
4410	720
4411	958
4412F	1650
4412F	1380
4415F	795
4415V	795
4419	280
4422	545
4433	995
4435	825
4440	1275
4450	295
4451	295
4490F	695
4490V	525
4501	19
4502	120
4503	69
4506	51
4507	55
4508	298
4510	99
4511	150
4512	98

LINEAR IC's

702★	75
709C 14 pin	35
710★	67
723★	45
733★	125
741C★ 8 pin	22
747C★	78
748C★	36
753★	150
810★	159
8038CC★	340
AY-1-0212	580
AY-1-1313★	315
AY-1-1320	315
AY-1-5050	180
AY-1-5051	145
AY-1-6721/6	195
AY-3-8500★	385
AY-5-1224A★	260
AY-5-1230★	450
AY-5-1315	560
AY-5-1317A	630
CA3011★	82
CA3020	170
CA3023	170
CA3028A★	80
CA3035	240
CA3043	190
CA3046★	71
CA3048	200
CA3075	175
CA3080E★	80
CA3081	190
CA3089E	210
CA3090AQ	398
CA3123E	200
CA3130★	85
CA3140★	80
ICL7106E★	795
ICL8038★	340
ICM7205★	1150
ICM7215★	1025
ICM7217★	775
LD130★	452
LF356★	98
LM301A	30
LM304	240
LM308★	95
LM318	195
LM324★	68
LM339★	60
LM348★	90
LM379★	375
LM380	90
LM381AN	248
LM382	122
LM1458★	58
LM3900★	60
LM3909N★	70
LM3911★	125
M252AA★	750
M253AA★	795
MC724★	175
MC1303	88
MC1304P	260
MC1310	149
MC1312P	195
MC1495★	390
MC1496★	92
MC1710★	79
MC3401	52
MC3403★	135
MC3340P★	120
MC3360P	120
MFC4000B	85
MFC6040★	97
MK50398★	635
MK50362★	650
MM2112★	105
MM2112-2★	210
MM5303★	635
MM57160★	620
NE518A★	210
NE555★	29
NE556DB★	60
NE560★	325
NE561★	395
NE562★	410
NE565A★	120
NE566★	160
NE567★	170
NE571★	450
RC4136D★	120
SAD1024A★	1250
SG3402	295
SN76003N	170
SN76013N	140
SN76023N	140
SN76033N	175
SN76115N	215
SN76477★	225
SN76227	115
TAA621AX1	228
TAA960	300
TAD1008★	310
TBA120S	70
TBA540Q	220
TBA641BX11	250
TBA651	180
TBA800	90
TBA810S	95
TBA820	70
TDA1004★	290
TDA1022★	595
TDA2020	320
TLO61CP★	48
TLO64CN★	199
TLO71CP★	76
TLO81CP★	52
TLO82CP★	96
TLO84CP★	130
UAA170	198
ZN414	90
ZN424	135
ZN425E★	415
ZN1034E★	195

TRANSISTORS

AC117★	35
AC125★	20
AC126★	20
AC127★	20
AC128★	20
AC141★	24
AC141K★	38
AC142★	24
AC142K★	38
AC176★	20
AC187★	20
AC188★	20
ACY17★	35
ACY18★	40
ACY19★	40
ACY20★	40
ACY21★	35
ACY22★	40
ACY28★	40
ACY39★	78
ACY40★	48
ACY44★	39
AD140★	68
AD149★	70
AD161★	42
AD162★	42
AF114★	30
AF115★	30
AF116★	30
AF117★	30
AF118★	55
AF121★	48
AF124★	55
AF125★	35
AF127★	35
AF139★	35
AF178★	70
AF180★	70
AF186★	50
AF239★	42
ASY26★	40
ASY27★	45
BC107★	9
BC107B★	10
BC108★	9
BC108B★	10
BC108C★	12
BC109★	9
BC109B★	12
BC109C★	12
BC113	20
BC114	20
BC115	20
BC116	20
BC117	20
BC118	20
BC119★	28
BC134	20
BC135	20
BC136	18
BC137	20
BC140★	35
BC142★	30
BC143★	30
BC147	7
BC148	7
BC149	8
BC153	27
BC154	27
BC157	10
BC158	11
BC159	11
BC160	42
BC167A	11
BC168C	12
BC169C	10
BC170	18
BC171	11
BC172	11
BC177★	18
BC178★	16
BC179★	18
BC182	9
BC182L	11
BC183	9
BC183L	11
BC184	9
BC184L	11
BC186	21
BC187★	28
BC212	10
BC212L	11
BC213	11
BC213L	12
BC214	9
BC214L	13
BC307B	20
BC308	20
BC328	15
BC338	12
BC441★	36
BC461★	36
BC477★	25
BC547	12
BC548	12
BC549C	13
BC557	13
BC558	20
BCY30★	57
BCY34★	75
BCY39★	80
BCY40★	78
BCY43	85
BCY58★	90
BCY59★	90
BCY70★	15
BCY71★	20
BCY72★	20
BCY78★	25
BD115★	65
BD121★	78
BD123★	98
BD124★	115
BD131★	45
BD132★	45
BD133★	43
BD135★	38
BD136★	37
BD137★	36
BD138★	50
BD139★	40
BD140★	36
BD142★	59
BD145★	198
BD222★	75
BD695A★	65
BD696A★	65
BDY17★	195
BDY60★	110
BDY61★	165
BF115★	34
BF154★	25
BF156★	29
BF167	30
BF173★	25
BF177★	24
BF /8★	25
BF179★	30
BF180★	35
BF181★	35
BF182★	35
BF183★	35
BF184★	38
BF194	12
BF195	12
BF196	12
BF197	14
BF198	18
BF200★	30
BF224A	18
BF244	29
BF256★	60
BF257★	30
BF258★	30
BF259★	30
BF394	27
BF594	40
BF595	38
BFR39	25
BFR40	28
BFR79	28
BFR80	28
BFX29★	28
BFX81★	45
BFX84★	26
BFX85★	28
BFX86★	28
BFX87★	28
BFX88★	28
BFY18★	50
BFY50★	20
BFY51★	20
BFY52★	20
BFY71★	20
BSX20★	18
BSY65★	30
BSY95★	25
BSY95A★	18
BU105	140
BU205★	190
BU208★	225
E5567	65
MD8001★	158
ME4102	10
ME6002	10
MJ400★	90
MJ491★	160
MJ2955★	120
MJE340★	54
MJE370★	58
MJE371★	60
MJE520★	65
MJE521★	74
MJE2955★	99
MJE3055★	70
MPF102	32
MPF103	36
MPF104	36
MPF105	36
MPF106	50
MPF107	50
MPSA05★	25
MPSA06★	25
MPSA12	42
MPSA55	25
MPSA56	25
MPSA70	34
MPSU02★	58
MPSU05	[illegible]
MPSU06	56
MPSU52★	65
MPSU55★	55
MPSU56★	60
MPU131★	39
OC25★	170
OC26★	170
OC28★	105
OC29★	160
OC35★	130
OC36★	130
OC41★	48
OC42★	32
OC43★	55
OC44★	31
OC45★	28
OC46★	28
OC70★	28
OC71★	28
OC72★	30
OC76★	36
OC77★	66
OC79★	76
OC81★	28
OC82★	40
OC83★	48
OC84★	44
OC122★	48
OC123★	48
OC139★	110
OC140★	110
OC141★	85
OC170★	40
OC171★	40
OC201★	75
OC202★	85
OC203★	85
OC204★	85
TIP29	43
TIP29A	44
TIP29C	60
TIP30	47
TIP30A	50
TIP30B	64
TIP30C	65
TIP31★	50
TIP31A★	50
TIP31B★	58
TIP31C★	66
TIP32★	55
TIP32A★	55
TIP32B★	70
TIP32C★	75
TIP33★	80
TIP33A★	80
TIP33B★	100
TIP33C★	110
TIP34★	85
TIP34A★	85
TIP34B★	110
TIP34C★	110
TIP35★	219
TIP35A★	225
TIP35C★	270
TIP36A★	280
TIP36C★	325
TIP41A★	66
TIP41B★	73
TIP42A★	72
TIP42B★	82
TIP2955★	65
TIP3055★	52
TIS43	34
TIS44	45
TIS46	45
TIS50	47
TIS60	45
TIS62	52
TIS74	47
TIS90	20
TIS91	24
ZTX107	12
ZTX108	12
ZTX109	14
ZTX300	15
ZTX301	15
ZTX302	20
ZTX303	25
ZTX304	24
ZTX311	17
ZTX314	24
ZTX326	30
ZTX341	20
ZTX500	15
ZTX501	15
ZTX502	19
ZTX503	15
ZTX504	25
ZTX531	25
ZTX550	25
2N526★	58
2N696★	35
2N697★	25
2N698★	44
2N699★	54
2N706A★	19
2N707★	39
2N708★	19
2N914★	32
2N916★	27
2N918★	40
2N920★	51
2N930★	18
2N961★	61
2N1131★	22
2N1132★	22
2N1302★	35
2N1303★	50
2N1304★	50
2N1305★	28
2N1306★	35
2N1307★	50
2N1308★	46
2N1613★	23
2N1670★	150
2N1671B★	215
2N1893★	28
2N1986★	60
2N2160★	350
2N2217★	43
2N2218A★	34
2N2219A★	20
2N2220A★	23
2N2221★	23
2N2222★	20
2N2297★	45
2N2303★	45
2N2368★	21
2N2369★	15
2N2476★	125
2N2483★	28
2N2484★	25
2N2646★	48
2N2784★	55
2N2846★	140
2N2894★	30
2N2904A★	22
2N2905A★	22
2N2906★	22
2N2907★	20
2N2907A★	22
2N2926G	10
2N2926O	8
2N2926R	8
2N2926Y	8
2N3011★	24
2N3053★	20
2N3054★	55
2N3055★	55
2N3108	32
2N3121	40
2N3133	43
2N3135	33
2N3250	30
2N3252	36
2N3302	30
2N3442★	131
2N3563	20
2N3614★	169
2N3615★	135
2N3663	26
2N3702	11
2N3703	11
2N3704	11
2N3705	11
2N3706	11
2N3707	11
2N3708	11
2N3709	11
2N3710	16
2N3711	12
2N3715★	250
2N3772★	195
2N3773★	288
2N3819	22
2N3820	45
2N3823★	65
2N3824★	70
2N3866★	90
2N3903	20
2N3904	18
2N3905	18
2N3906	17
2N4037★	52
2N4058	17
2N4061	17
2N4064★	120
2N4236★	45
2N4289	20
2N4859	65
2N5135	42
2N5136	42
2N5138	20
2N5179★	60
2N5180★	60
2N5191★	70
2N5305★	40
2N5457	32
2N5458	32
2N5459	32
2N5485	35
2N5777★	45
2N6027	40
40311★	50
40313★	125
40316★	85
40317★	52
40324★	85
40326★	52
40327★	62
40347★	80
40348★	105
40360★	43
40361★	45
40362★	45
40407★	52
40411★	295
40412★	65
40467★	95
40576★	190
40594★	90
40595★	98
40603★	58
40636★	125
40673★	68

Diodes

IN4148	4
CRO33★	148
Zeners 400mw 2.7-33v	9

EMI SPEAKER BARGAIN

Stereo pair 350 kit. System consists of 13" x 8" approx. woofer with rolled surround, 2½" approx. Audax tweeter, crossover components and circuit diagram. Frequency response 20 Hz to 20 KHz. Power handling 15 watts RMS. 20 watts max. 8 ohm impedance.

£14.95 Per stereo pair + £3.40 p&p.

As above but complete with all woodwork in kit form, finished in simulated teak veneer, with instructions. Size approx 20" x 11" x 9½" **£28.00** Per stereo pair + £5.00 p&p.

BSR Manual single play record deck with auto-return and cueing lever, fitted with stereo ceramic cartridge 2 speeds with 45 r.p.m. spindle adaptor ideally suited from home or disco use OUR PRICE **£10.95** p&p £2.55

TURNTABLE BARGAINS FOR PERSONAL SHOPPERS

GARRARD 86SB Deck **£26.95** | GARRARD SP25 MKIV Deck with Shure head. **£25.95**

Plinth and cover for BSR decks **£6.00**

BARGAINS FOR PERSONAL SHOPPERS

PORTABLE STEREO RADIO CASSETTE RECORDER UNREPEATABLE MW, LW, SW and Stereo VHF. 6 watts output Battery/Mains operation. **£69.95**

16o 16 VOLT MAINS TRANSFORMER. 2½ amp. **£2.50**

Garrard Record auto deck on plinth with stereo cartridge ready wired. **£18.95**

LED 5 function men's digital watch stainless steel finish **£5.95**

LCD 5 function men's digital watch stainless steel finish **£6.95**

LCD 8 Function CHRONOGRAPH men's digital watch, stainless steel finish. **£13.95**

BATTERY/MAINS CASSETTE RECORDER with built in mic. **£12.95**

AM/FM DIGITAL CLOCK RADIO Accurate 4 Digit Electronic Clock with ½" LED display. Buzzer and snooze timer. **£11.95**

125 Watt Power Amp Module **£13.95**

Mains power supply for above unit. **£3.50**

MUSIC CENTRE CABINET with hinged smoke acrylic top, finished in natural teak veneers, size 30¼" x 14½" x 7¾" approx. **£5.95**

MULLARD Built power supply **£1.50**

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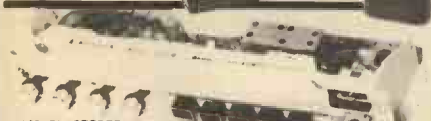

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7 watts speech and music.
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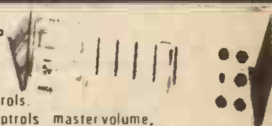

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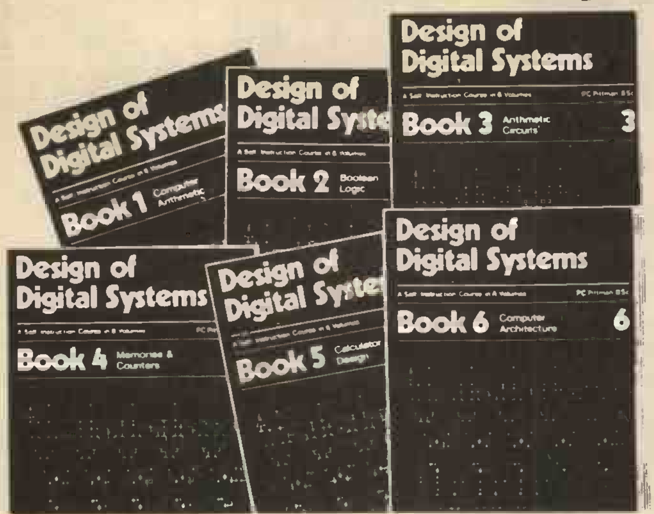

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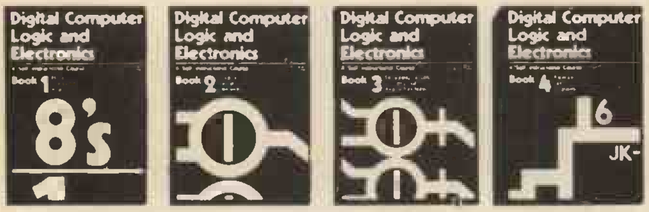
Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.

Book 6 Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.



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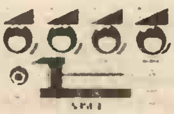

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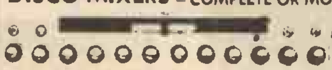

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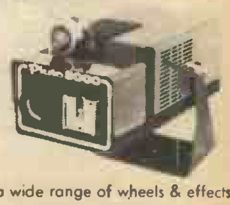

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BP222	Solid State Short Wave Receivers for Beginners	£0.95	£0.86
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BP224	50 CMOS IC Projects	£0.95	£0.86
BP225	A Practical Introduction to Digital ICs	£0.95	£0.86
BP226	How to Build Advanced Short Wave Receivers	£1.20	£1.08
BP227	Beginners Guide to Building Electronic Projects	£1.25	£1.13
BP228	Essential Theory for the Electronics Hobbyist	£1.25	£1.13

VPS30 Variable Regulated Stabilised Power Supply Module

Incorporating a short circuit protection and current limiting:

Voltage Regulation	2-30V
Regulated Current	0-2A
AC Input Maximum	25V

Eliminates the use of batteries and thus saves £'s-can be used time and time again ONLY £7.60 + V.A.T.

BRAND NEW
ITT 923 Silicon Diodes 200mA 200v.

100 off	–	£ 2.00
500 off	–	£ 9.00
1000 off	–	£ 15.00
10,000 off	–	£130.00

P.C. BOARD

Single-Sided Fibre Glass Board 12" x 3½" approx. 2 pcs **£0.60**
S143

THYRISTORS

No. THY1A/50	1 Amp	50 volt	TO5	18p
No. THY1A/400	1 Amp	400 volt	TO5	32p
No. THY3A/50	3 Amp	50 volt	TO64	25p
No. THY3A/200	3 Amp	200 volt	TO64	32p
No. THY3A/400	3 Amp	400 volt	TO64	40p
No. THY5A/50	5 Amp	50 volt	TO66	25p
No. THY5A/400	5 Amp	400 volt	TO66	40p
No. THY5A/600	5 Amp	600 volt	TO66	50p
No. C106/4	6 Amp	400 volt	TO220	42p

TRIAC

S84 8 Amp 400 volt TO220 80p

DIACS

ITT.	V413 equt	12p
BR100	D32 each	12p

CAPACITOR PAKS

16201	18 Electrolytics	4.7µF – 10µF
16202	18 Electrolytics	10µF – 100µF
16203	18 Electrolytics	100µF – 680µF

All 3 at SPECIAL PRICE of £1.20°

16160	24 Ceramic Caps	22pF – 82pF
16161	24 Ceramic Caps	100pF – 390pF
16162	24 Ceramic Caps	470pF – 3300
16163	21 Ceramic Caps	4700pF – 0.047µF

All 4 at SPECIAL PRICE of £1.60°

RESISTOR PAKS

Order No.		
16213	60 ¼W.	100 ohm – 820 ohm
16214	60 ¼W.	1K – 8.2K
16215	60 ¼W.	10K – 82K
16216	60 ¼W.	100K – 820K

All 4 at SPECIAL PRICE of £1.60°

16217	40 ½W.	100 ohm – 820 ohm
16218	40 ½W.	1W – 8.2K
16219	40 ½W.	1K – 8.2K
16220	40 ½W.	100K – 820K

All 4 at SPECIAL PRICE of £1.60°

VOLTAGE REGULATORS

Positive

No. MVR7805	µA7805	TO220	55p
No. MVR7812	µA7812	TO220	55p
No. MVR7815	µA7815	TO220	55p
No. MVR7818	µA7818	TO220	55p
No. MVR7824	µA7824	TO220	55p

Negative

No. MVR7905	µA7905	TO220	75p
No. MVR7912	µA7912	TO220	75p
No. MVR7915	µA7915	TO220	75p
No. MVR7918	µA7918	TO220	75p
No. MVR7924	µA7924	TO220	75p

µA723C TO99 38p   72723 14 pin Dil 38p
LM309K TO3 £1.20

SWITCHES

No. 16178	5 x Mains Slide Switches	40p°
No. S17	5 x Miniature Slide Switches	40p°
No. S18	4 x Standard Slide Switches	40p°
No. S19	4 x Miniature Push to Make single hole mounting	40p°
No. S20	3 x Miniature Push to Break single hole mounting	40p°
No. S21	Push button Switch Pak 4 x Assorted types multi bank and singles Latching and non-Latching	£1.00°

AUDIO LEADS

Order No.		
127	Audio lead 5 pin DIN plug to 4 phono plugs	90p°
129	Audio lead 5 pin plug to 5 pin DIN plug – Mirror Image	70p°
130	5 metre lead 2 pin DIN plug to 2 pin DIN inline socket	45p°

AUDIO PLUG AND SOCKET PAKS

Order No.		
S1	5 x 3.5 mm Plastic Jack Plugs	40p°
S2	5 x 2.5 mm Plastic Jack Plugs	40p°
S3	4 x Std. Plastic Jack Plugs	50p°
S4	2 x Stereo Jack Plugs	30p°
S5	5 x 5 Pin 180° DIN Plugs	50p°
S6	8 x 2 Pin Loudspeaker Plugs	50p°
S7	6 x Phono Plugs Plastic	50p°
S8	5 x 3.5 mm Chassis Sockets(Switched)	25p°
S9	5 x 2.5 mm Chassis Sockets(Switched)	25p°
S11	2 x Stereo Jack Sockets with instruction leaflet for H/Phone connection.	50p°
S12	5 x 5 Pin 180°DIN Chassis Sockets	40p°
S13	8 x 2 Pin DIN Chassis Sockets	50p°
S14	6 x Single Phono Sockets	40p°

P.C. BOARD

S110 Mixed Bundle. P.C.B., Fibre-glass/paper, single and double-sided. Fantastic value 75p

SPECIAL OFFER!

UNTESTED SEMICONDUCTOR PAKS

Code No's shown below are given as a guide to the type of device. The devices themselves are normally unmarked.

No. 16130	100 Germ. Gold bonded diodes like OA47	40p
No. 16131	150 Germ. Point contact diodes like OA70/81	40p
No. 16132	100 200mA Sil. diodes like OA200	40p
No. 16133	150 75mA Sil. Fast switching diode like IN4148	40p
No. 16134	50 750mA Sil. top hat Rects.	40p
No. 16135	20 3 amp Sil. stud Rect.	40p
No. 16136	50 400mw Zeners D.O.7 case	40p
No. 16137	30 NPN Plastic trans. like BC107/8	40p°
No. 16138	30 PNP Plastic trans. like BC177/8	40p°
No. 16139	25 NPN trans. like 2N697/2N1711 TO39	40p
No. 16140	25 PNP trans. like 2N2905 TO39	40p
No. 16141	30 NPN trans. like 2N706 TO18	40p
No. 16143	30 NPN Plastic trans. like 2N3906	40p°
No. 16144	30 PNP Plastic trans like 2N3905	40p°
No. 16145	30 PNP Germ. trans. like OC71	40p
No. 16147	10 NPN to 3 Power trans. like 2N3055	80p

I.C. SOCKET PAKS

No. S66	11 x 8 pin DIL Sockets	£1.00
No. S67	10 x 14 pin DIL Sockets	£1.00
No. S68	9 x 16 pin DIL Sockets	£1.00
No. S69	4 x 24 pin DIL Sockets	£1.00
No. S70	3 x 28 pin DIL Sockets	£1.00

MAMMOTH I.C. PAK

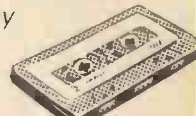
Approx. 200 pieces Assorted fall-out integrated circuits, including Logic 74 series, Linear, Audio and D.T.L. Many coded devices, but some unmarked—you to identify.
Order No. 16223 **£1.00**

MATCHED PAIRS OF PNP GERMANIUM MED. POWER TRANS

2 amp 750mW

	VCE	VCB	HFE	
NKT301	40	60	30-100	35p per pair
NKT302	40	60	50-150	35p per pair
NKT303	20	30	30-100	25p per pair
NKT304	20	30	50-150	25p per pair

From U.S.A. by DINDY
SCREW CASED
LOW NOISE CASSETTES



C90

Order No. S53 **10 for £3.50**

HEAD-CLEANING CASSETTE **45p** each

AUDIO AMPLIFIER RETURN OF THE AL20A

By popular demand – this useful 5 watt RMS Power Amplifier is offered at the re-introductory price of £2.75° – Hook-up data supplied.

ETCH RESIST PENS

Order No. 1609   50p each

UNIJUNCTION TRANSISTORS

UT46   TIS43   20p

FET's

2N3819   15p   2N5458   18p

2 AMP. BRIDGE RECTIFIERS

Metal Stud Mounting

No. S45	50V	(KBS 005)	28p
No. S46	100V	(KBS 01)	30p
No. S47	200V	(KBS 02)	34p

SILICON BRIDGE RECTS.

S99   Mixed Pak 2 – 5 Amp. 50–600v. All coded. 4 for   £1.00°

SILICON RECTS.

SIMILAR IN4000 SERIES

No. S41	25 Like IN4001 (1A 50V)	60p
No. S42	20 Like IN4002 (1A/100V)	60p
No. S43	18 Like IN4003 (1A/200V)	60p
No. S44	15 Like IN4004 (1A/400V)	60p

SALE T-T-TIME again!

SPECIAL OFFER!

COMPONENT PAKS

Order No.	Quantity	
16168	5 pieces Assorted Ferrite rods	40p
16169	2 pieces Tuning gangs MW/LW	40p
16170	50 metres Single strand wire assorted wire	40p
16171	10 Reed switches	40p
16172	3 Micro switches	40p
16176	20 Assorted electrolytics Trans types	40p
16177	1 pack Assorted Hardware nuts/bolts etc.	40p
16179	20 Assorted tag strips and panels	40p
16180	15 Assorted control knobs	40p
16184	15 Assorted Fuses 100mA-5 amp	40p
16188	60 ½W resistors mixed values	40p
16187	30 metres stranded wire assorted colours	40p
S100	120 ¼ watt resistors. Pre-formed. 1978 Prod. Our mix	60p•
S101	120 ⅛ watt resistors. Pre-formed. 1978 Prod. Mixed values	60p•
S102	250 ⅛ watt resistors. Range 100 ohms – 1.8 meg.	£2.00•
S103	220 ¼ watt resistors. Range 100 ohms – 10 meg.	£2.00•
S104	60 Low ohms ½ watt resistors. 10 – 100 ohms	60p•
S105	40 Low ohms ¼ watt resistors. 12 – 100 ohms	60p•
S106	25 Mixed wirewound resistors	60p•
S107	20 Tantalum bead caps 0.22 – 100mF Our mix	£1.00•
S108	High quality electrolitics 10mF–500mF voltage range 15–50v. Our mix. 40 for	£1.00•
16204	C280 Pak. Contains 50 metal foil caps	£1.00•

POTENTIOMETERS

Slider 40mm TRAVEL

Order No.			
16191	6 x 470 Ohm	LIN Single	40p•
S24	6 x 1 K	LIN Single	40p•
S25	6 x 5 K	LIN Single	40p•
16193	6 x 22 K	LIN Single	40p•
16195	6 x 47 K	LOG Single	40p•
16194	6 x 47 K	LIN Single	40p•
S27	6 x 100 K	LIN Single	40p•
S28	6 x 100 K	LOG Single	40p•
S29	6 x 500 K	LOG Single	40p•
S32	6 x 50 K	LIN Single	40p•

Slider 60mm TRAVEL

S30	6 x 2.5 K	LOG Single	40p•
S34	4 x 5 K	LOG Dual	40p•
S36	4 x 100 K	LOG Dual	40p•
S37	4 x 1.3 MEG	LOG Dual	40p•
S94	6 x 220 K	LIN Single	40p•
S95	6 x 100 K	LOG Single	40p•
S96	6 x 500 K	LIN Single	40p•
S38	Mixed slider pots – various values and sizes – our mix		only £1.00•
S39	6 x Chrome slider knobs		40p•

WIREWOUND

S90 Wirewound Pots. Linear 1 Watt rating. Mixed useful values. 5 for £1.00•

CARBON TYPES

S91 Car Radio type. Dual Switched Pot P.C. mounting 100 K Lin switched 2.5 K Lin — each 60p•

DUAL POTS P.C. MOUNTING

6mm Shaft

S92	4 x 100 K Lin	£1.00•
S93	4 x 100 K Log	£1.00•
16173	15 Rotary Pot Assorted	40p•
16186	25 Pre-sets Assorted Values	40p•

ZENER PAKS

No. S55	20 mixed values 400mW Zener diodes 3-10V	£1.00
No. S56	20 mixed values 400mW Zener diodes 11-33V	£1.00
No. S57	10 mixed values 1W Zener diodes 3-10V	£1.00
No. S58	10 mixed values 1W Zener diodes 11-33V	£1.00

SILICON POWER TRANS. N.P.N.

S97 BD371 2 Amp 1.2w. 60Vceo Hfe 40–400, Case TO92 with heat tab. 5 for — 60p•

S98 2N5293 R.C.A. 36w 4 Amps 75Vceo Hfe 30–120. 5 for — £1.00•

Crystal Ear Pieces
S126 Less plug — £0.20•

Plugs for above
No. 16106 2.5 plastic — £0.09•
No. 1697 3.5 plastic — £0.11•

Mono Crystal Cartridge
S127 GP91/1SC Special Offer — £1.00•

Nickel Cadnium Rechargeable Batteries 1.25V
S128 3500D Cell size=U2 — £2.50
S129 900C Cell size=½U11 — £0.90

S130 Complete kit of parts to build nickel cadnium charger — £3.50

Super Save Pak
S124 6 x 741P — £1.00•
S125 5 x 555 — £1.00

S138 Surplus/End of Manufacturers Line/ Pre-amp, with Base, Treble, Volume Control & circuit diagram supplied. ONCE ONLY OFFER — £1.25•

S137 20 Assorted Slider Knobs – Chrome/Black — £1.00•

S131	2 x 12v Relays plastic case	£0.70•
S132	2 x 24v Relays plastic case	£0.60•
S133	1 switch bank 5 way incl. silver knob	£0.75•
S134	2 x Magnets suitable for reed switches	£0.10
S135	.1 Veroboard pak 2 pcs 45 sq.ins. approx.	£0.80
S136	.15 Veroboard pak 2 pcs 60 sq. ins. appx.	£1.10
16199	.1 Veroboard pak pcs 30 sq. ins appx.	£0.50
16200	.15 Veroboard pak pcs 30 sq. ins. appx.	£0,50

TOOLS

No. 2011 5" wire cutters — £1.55
No. 2012 5" long wire plyer — £1.45

SUPER DUPER COMPONENT BOX

Min. 3lbs in weight consisting of a fantastic assortment of Electronic Components – Pots, Resistors, Condensers, Switches, Relays, Board – Semiconductors, wire, hardware, Etc., etc.,

•This is a large box and is sent separate to your order• £2.50 including p & p.
S140

TRANSFORMERS *SALE OFFER*

S141 0235 240v primary, 0-55v at 2 amps secondary. £4.50• + £1.00 p&p.

S142 0349 240v primary, 0-20v at 2Amp secondary. £3.50• + £0.86 p&p.

COMPLETE AUDIO AMPLIFIER KITS:

STA15 15 watts per channel amplifier kit Consists: 2 x AL60–1 x PA100–1 x SPM80 1 x 2034 transformer– 2 x coupling capacitors — £37.70 inc VAT + .86p pOp

STA25 25 watts per channel amplifier kit. Consists: 2 x AL60–1 x PA100–1 x SPM120/45 1 x 2040 Transformer –1 x reservoir cap 2 x coupling capacitors — £41.45 inc VAT + £1.16p p& p

STA35 35 watts per channel amplifier kit. consists: 2 x AL80–1 x PA100–1 x SPM120. 1 x 2041 transformer— 1 reservoir capacitor 2 x coupling capacitors — £48.45 inc VAT + £1.16p p & p

STA50 50 watts per channel amplifier kit. Consists: 2 x AL120–1 x PA200–1 x SPM120/65 1 x 2041 transformer –1 x reservoir capacitor 2 x coupling capacitors — £58.20 inc VAT + £1.10p p & p

STA125 125 watts per channel amplifier kit. Consists: 2 x AL250–1 x PA200 –2 x SPM120/65 2 x 2041 transformers– 1 x reservoir capacitor 2 x coupling capacitors — £72.85 inc VAT + £1.25p p & p

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TRANSISTORS

BRAND NEW — FULLY GUARANTEED

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC107	25p	BC177	12p	BF194	•9p	TIP32A	34p	2N1613	15p
AC126	14p	BC178	12p	BF195	•9p	TIP32B	35p	2N1711	15p
AC127	16p	BC179	12p	BF196	•12p	TIP32C	36p	2N1893	28p
AC128	16p	BC182	•9p	BF197	•12p	TIP41A	34p	2N2218	15p
AC128K	24p	BC182L	•9p	BF200	25p	TIP41B	35p	2N2218A	18p
AC176	16p	BC183	•9p	BFX29	22p	TIP41C	36p	2N2219	15p
AC176K	24p	BC183L	•9p	BFX84	18p	TIP42A	36p	2N2219A	18p
AC187	16p	BC184	•9p	BFY50	12p	TIP42B	37p	2N2221	15p
AC187K	26p	BC184L	•9p	BFY51	12p	TIP42C	38p	2N2221A	16p
AC188	16p	BC212	•10p	BFY52	12p	TIP2955	65p	2N2222	15p
AC188K	26p	BC212L	•10p			TIP3055	42p	2N2222A	16p
AD161		BC213	•10p	MPSA05	•22p	ZTX107	•6p	2N2369	10p
162MP	80p	BC213L	•10p	MPSA06	•22p	ZTX108	•6p	2N2904	14p
AF139	30p	BC214	•10p	MPSA55	•22p	ZTX109	•7p	2N2904A	15p
AF239	30p	BC214L	•10p	MPSA56	•22p	ZTX300	•7p	2N2905	14p
BC107	6p	BC251	•10p			ZTX301	•7p	2N2905A	15p
BC108	6p	BCY70	12p	OC44	12p	ZTX302	•9p	2N2906	12p
BC109	6p	BCY71	12p	OC45	12p	ZTX500	•8p	2N2906A	14p
BC118	•10p	BCY72	12p	OC71	9p	ZTX501	•10p	2N2907	12p
BC147	•8p	BD115	•40p	OC72	12p	ZTX502	•12p	2N2907A	13p
BC148	•8p	BD131	•35p	OC75	10p	2N696	10p	2N2926G	•8p
BC149	•8p	BD132	•37p	OC81	14p	2N697	10p	2N2926Y	•7p
BC154	•16p	BF115	17p	TIP29A	35p	2N706	7p	2N3053	12p
BC157	•9p	BF167	19p	TIP29B	36p	2N706A	8p	2N3055	35p
BC158	•9p	BF173	20p	TIP29C	38p	2N708	8p	2N3702	•7p
BC159	•9p	BF180	25p	TIP30A	36p	2N1302	12p	2N3703	•7p
BC169	•10p	BF181	25p	TIP30B	37p	2N1303	15p	2N3704	•6p
BC169C	•6p	BF182	25p	TIP30C	38p	2N1304	15p	2N3903	•11p
BC171	•6p	BF183	25p	TIP31A	32p	2N1307	18p	2N3904	•11p
BC172	•6p	BF184	25p	TIP31B	33p	2N1308	22p	2N3905	•11p
BC173	•7p	BF185	25p	TIP31C	34p	2N1309	22p	2N3906	•11p

RESISTORS

40 mixed values 1 watt & 2 watt Resistors no S143 — £0.60•

PROGRAMMABLE UNIJUNCTIONS

2N6027 with Data — £0.24

DIODES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AA119	5p	BAX16/		BYZ16	30p	OA85	7p	IS44	3p
AAZ13	4p	OA202	5p	BYZ17	28p	OA90	6p		
BA100	6p			BYZ18	28p	OA91	7p	IN5400	10p
BA115	5p	BY100	15p	BYZ19	28p	OA95	7p	IN5401	11p
BA144	5p	BY127	•10p					IN5402	12p
BA148	10p	BYZ10	32p	OA47	5p	IN34	5p	IN5404	13p
BA173	10p	BYZ11	32p	OA70	5p	IN60	6p	IN5406	16p
BAX13/		BYZ12	32p	OA79	7p	IN914	4p	IN5407	17p
OA200	5p	BYZ13	30p	OA81	7p	IN4148	4p	IN5408	19p

LINEAR I.C.'s

TBA800	£0.75•	UA711	£0.25•	UA748	£0.28•
TBA810	£0.85•	UA703	£0.20•	72558	£0.45•
TBA820	£0.65•	741P	£0.18•	MC1310P	£1.25•
LM380	£0.80•	72741	£0.20•	76115	£1.25•
LM381	£1.25•	UA741C	£0.20	NE555	£0.22
72709	£0.20	72747	£0.55•	SL414A	£1.80•
UA709	£0.20	748P	£0.28•		

ZN 414 RADIO CHIP 75•

OPTOELECTRONICS

Displays

No. 1510 707 LED Display — £0.70
No. 1511 747 LED Display — £1.50
No. 1512 727 Dual LED Display — £1.55

LED's

No. S120 .125	Bright Red	£0.09
No. S121 .2	Bright Red	£0.09
No. 1502 .125	Green	£0.12
No. 1505 .2	Green	£0.12
No. 1503 .125	Yellow	£0.12
No. 1506 .2	Yellow	£0.12
No. S82	Clear .2 illuminating Red	£0.10

2nd Quality Led Paks

No. 1507	10 Assorted Colours & Size		£0.75
No. S122	10 x .125 Red		£0.60
No. S123	10 x .2 Red		£0.60
LED Clips			
No. 1508/.125	.125	5 for	£0.12
No. 1508/.2	.2	5 for	£0.15

No. S139 Infra Red Emitter
Fairchild FPE100 — £0.50

SPECIAL REDUCTIONS

No. 1514 NORP 12 — each 45p
No. S76 OCP71 — 5 for £1.00
No. S83 5 NIXIE Tubes ITT 5870 ST (including Data) — £2.00
No. S77 Neon Indicator Lamps 230V A.C. State Colour (Red, Amber and Green.) — 25p each

P.O. RELAYS

S85 – 2 Off Post Office relays 40p•

BATTERY HOLDERS

to take 6 x HP7's
Order No. 202 — each 10p

EX. G.P.O. MICROSWITCHES

Order No. S51 — 4 for 50p

CABLE CLIPS

S65 – 50 2.5mm round single pin fixing — 30p

POWER SUPPLY STABILIZER BOARD

Unused ex-equipment stabilizer board, Input 30V. D.C. Output 20V. Complete with circuit diagram.
Order No. S81 — £1.25•

ORDERING

Minimum postage and packing for Sale Orders £0.50 PLUS any further postage as stated as per this Sale Advertisement

Overseas Orders – ADD extra for Air-mail

V.A.T.

Please ADD V.A.T. as follows:
12½% to items marked •   8% to unmarked items   NO V.A.T. on Books

SEND FOR YOUR BI-PAK CATALOGUE 65p post free.

I.C. INSERTION EXTRACTION TOOLS O/N 2015 30p each

BI-PAK

DEPT. PE3, P.O. Box 6, Ware, Herts

COMPONENTS SHOP: 18 BALDOCK STREET, WARE, HERTS.

AND OTHER PROJECTS

PHOTOGRAPHS in this advertisement show two of our units containing some of the P.E. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available.

LIST—Send stamped addressed envelope with all U.K. requests for free list giving fuller details of PCBs, kits and other components.

OVERSEAS enquiries for list Europe—send 20p: other countries—send 50p.

KIMBER-ALLEN KEYBOARDS AND CONTACTS

Kimber-Allen Keyboards as required for many published circuits. The manufacturers claim that these are the finest moulded plastic keyboards available. All octaves are C to C, the keys are plastic, spring-loaded, fitted with actuators, and mounted on a robust aluminium frame.

3 Octave (37 notes)	£25·50
4 Octave (49 notes)	£32·25
5 Octave (61 notes)	£39·75

Contact Assemblies (gold-clad wire) for use with the above KBDS (1 for each note):

Type GJ: Single-pole change-over	each 25½p
Type GA: 1 pair of contacts, normally open	each 24p
Type GB: 2 pairs of contacts, each pair normally open	each 28½p
Type GC: 3 pairs of contacts, each pair normally open	each 37½p
Type GE: 4 pairs of contacts, each pair normally open	each 46½p
Type GH: 5 pairs of contacts, each pair normally open	each 58½p
Type 4PS: 3 pairs of contacts plus single-pole changeover	each 57p

Printed Circuit Boards for use with most contacts (thus eliminating much interwiring) are available. Details in our lists.

P.E. TUNING FORK (P.E. Nov. 75)
Produces 84 switch-selected frequency-accurate tones. A LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic or electronic musical instruments.

Main component set (incl. PCB)	£14·93
Power supply set (incl. PCB)	£6·28

SYNTHESISER TUNING INDICATOR (P.E. July 77)
A simple 4-octave frequency comparator for use with synthesisers and other instruments where the full versatility of the P.E. Tuning Fork is not required.

Component and PCB (but excl sw.)	£7·45

CONSTANT DISPLAY FREQUENCY METER (PE AUG 78)
A 5-digit frequency counter for 1Hz to 99999Hz with a 1Hz sampling rate. Readout does not count visibly or flicker due to display blanking.

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PE VOLUME 15 No. 3 MARCH 1979

PROSPECTS

AT THE time of writing we are at the start of a new year—a year which is an exciting prospect for the whole of the electronics industry. Every man in the street has now heard of the "chip" and we have all seen or at least read about the many products now available because of it. The next year should see hundreds more products and the microprocessor boom take off in a big way in the U.K.

Digital watches and calculators are now cheap, efficient and available in vast varieties to suit every requirement. Video recorders—promised for so long—are now a reality, as is the videodisc in the States, but may not be here until 1980. Perhaps we will see the introduction of electronics to our everyday transport during 1979. Solid state instruments are at present undergoing evaluation tests and it will not be too long before the microprocessor helps present every driver with better information and perhaps provide in-car entertainment for the kids.

TV

The P.O. Prestel system will become widely available and we should start to see cheaper Oracle, Ceefax and Prestel equipped sets, though we doubt if many homes will be in touch with these systems by the end of '79. By then we may know for sure what and when our fourth TV channel will be—though having been subjected to North American TV we see no argument for continuing to add to the number of channels. TV games continue to become more sophisticated but with tape programmed computerised versions already around we doubt if '79 will see any further significant steps.

CB

We may also see some moves by the Government on citizens band radio, even if they are only attempts to stamp out the numerous illegal networks operating in our large cities at the present time. Maybe this illegal use will force the powers that be to assign a frequency for CB. We would not however expect this to provide a great advantage to the man in the street as it is highly probable that the alloted frequency will not be in the 27MHz band, but much higher and that the technical spec. for each set will be high and closely controlled, making equipment expensive.

This would however overcome the interference problems of 27MHz and would probably provide a much more usable network for those that could justify the expense. If CB does come to Britain we hope the communications companies will be quick off the mark with British designed—if not made—equipment!

REVOLUTION

Of course all this new technology will require new test equipment and this, together with "the next industrial revolution", of which many are talking, will probably be a far greater growth area than all those mentioned previously.

One "new product" which is now being used in the home and small business has not been mentioned above—the microcomputer. The Tandy catalogue, given free with our UK mainland issues this month, features their TRS 80 computer—probably the best selling micro in the world—and next month we hope to bring you a review of a Level II machine.

Mike Kenward

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Editorial Offices:
Westover House,
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LOGISCOPE

R.A.PENFOLD

WHILE a dual or multi-trace oscilloscope is in many ways ideal for checking logic circuits, the high cost of such an instrument is the main reason for the large number of logic tester designs that appear in electronic magazines.

Most logic testers are designed to show whether a test point is a logic 0, logic 1, floating, or pulsing. Such units can be extremely useful, but the fact that they merely indicate the presence of a pulsed input and do not usually provide any information about mark space ratio or frequency can be a drawback.

A few logic tester designs attempt to overcome this problem to some degree, and the unit described in this article can be used to give some idea of the mark space ratio and frequency of the input signal in most cases.

DISPLAY

This unit relies upon the fact that for the majority of logic testing the high definition of a cathode ray tube is considerably in excess of the minimum requirement, and a much simpler form of display can therefore be used. The reason for this is that in logic circuits the waveforms are produced by rapid switching between the two logic levels. This tends to produce oscilloscope traces of the type illustrated in Fig. 1a. There are really only two levels on the Y axis, which correspond to logic 0 and logic 1. Obviously there are parts of the trace at intermediate levels, but as the switching action takes place extremely rapidly the intermediate parts of the trace are extremely faint, and may well not be visible at all.

A simple waveform of this type could be displayed on two rows of l.e.d.s as shown in Fig. 1b, and with further simplification a single row of l.e.d.s could be used in the manner illustrated in Fig. 1c. In the case of the latter, a l.e.d. is either switched on to indicate a logic 1 level, or switched off to indicate a logic 0 level.

Ideally a l.e.d. display of this type would have a large number of very small l.e.d.s in order to achieve the most accurate and meaningful results. However, in practice this would be difficult to achieve, and the unit described here uses a row of ten ordinary 3mm diameter l.e.d.s. This seems to provide acceptable results in most cases, and enables a circuit to be used which is no more complicated than many conventional logic testers.

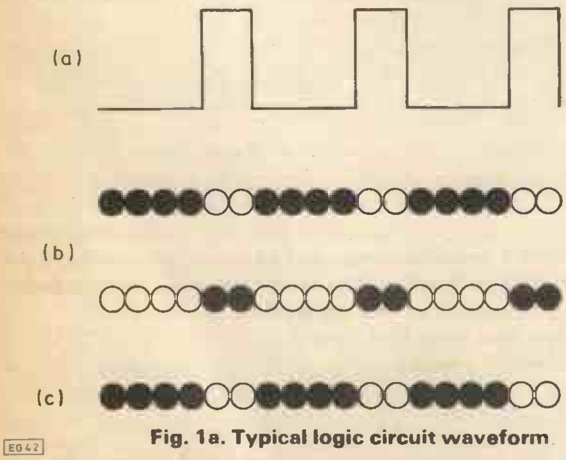


Fig. 1a. Typical logic circuit waveform

Fig. 1b and 1c. The same waveform displayed first using two rows of l.e.d.s then one

BLOCK DIAGRAM

Although in operation this device is analogous to an ordinary oscilloscope, it employs digital rather than analogue techniques, and is of course very much simpler than an oscilloscope. Fig. 2 shows in block diagram form the general arrangement of the unit.

The timebase section of the circuit consists of a clock oscillator feeding a one of ten decoder, the ten outputs of this device being used to drive the display of ten l.e.d.s. As the name implies, one output of the one of ten decoder will be in the logic 1 state and the others will be at the logic 0

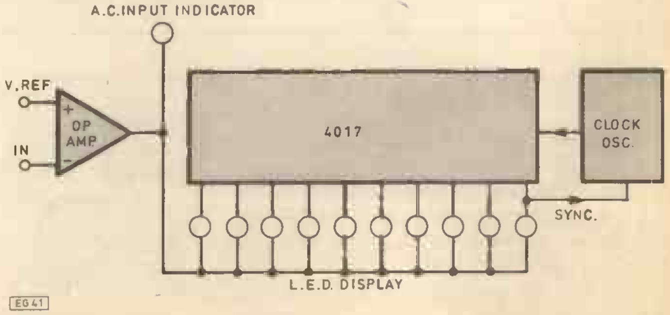
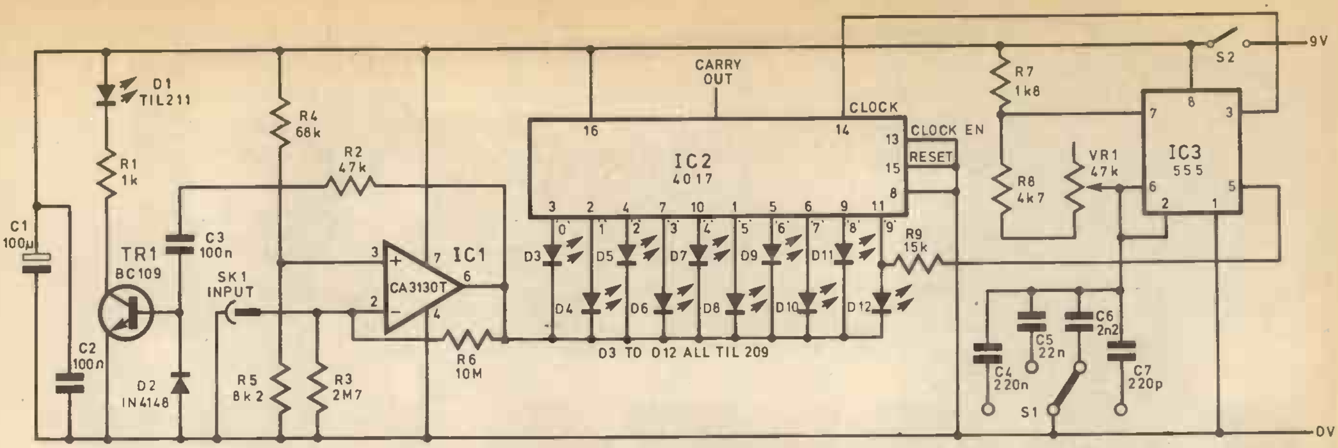


Fig. 2. Block diagram of the Logiscope



EG40

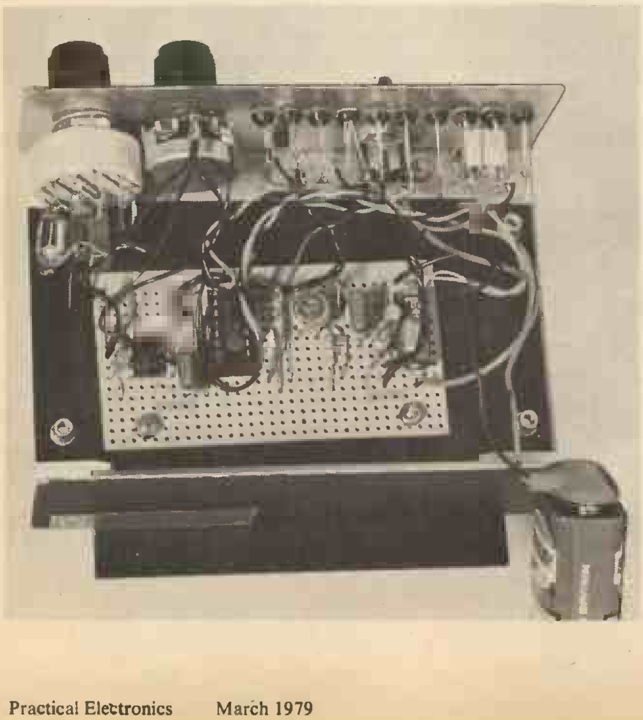
Fig. 3. Complete circuit diagram of the Logiscope

level. Initially output "0" will be at logic 1, but on successive clock cycles outputs "1" to "9" will go to logic 1 in sequence. After output "9" has been in the high state for one cycle, the next cycle causes output "0" to go high, and then the sequence commences once again

If the common connection to the l.e.d. display is taken to logic 0, each l.e.d. will be strobed on in turn, and this sequence will be repeated continuously. The effect is much the same as the electron beam being continuously scanned across a CRT, and there will appear to be a continuous line of illuminated l.e.d.s as this action will occur too fast for the eye to perceive what is happening.

If the common connection to the display is taken to logic 1, there will either be zero bias or a reverse bias across the diodes in the display, depending upon the state of the output driving each particular diode. In either case the diodes will not light up.

The common connection of the display is actually driven from the output of an operational amplifier which is used as a comparator. The non-inverting input is taken to a reference voltage and the inverting input is coupled to the input signal. If the input is at logic 0 the inverting input will be at a lower voltage than the non-inverting input, the output will go high, and the l.e.d.s will not come on. Taking the input to the logic 1 state will reverse the comparative input levels, the output will go low, and the l.e.d.s will light up. The circuit is arranged so that with a floating input the output of the comparator is at approximately half the supply voltage. Thus, display off, display on, and display dimmed correspond to input states of logic 0, logic 1, and floating, respectively.



A simple indicator circuit driven from the output of the comparator will indicate the presence of a pulsed input. The timebase frequency would then be adjusted to a factor of the input frequency in order to show the mark space ratio of the input signal. For example, if the input signal is a 100kHz squarewave, adjusting the timebase frequency to 20kHz would result in every other l.e.d. being switched on, and the correct one to one mark space ratio being displayed. Of course, the timebase frequency must be synchronised to the input signal in the correct way otherwise the result might simply be that each l.e.d. would be switched on for part of the time. A suitable sync. circuit is incorporated in the device.

THE CIRCUIT

This is shown in Fig. 3, and IC1 is the comparator op. amp. The CA3130 is used here as it is capable of quite fast operation (30V/µS slew rate) and has good compatibility with the CMOS display decoder/driver (the CA3130 has a CMOS output stage). R4 and R5 provide a suitable reference voltage for the non-inverting input and R3 plus R6 bias the output to about half the supply potential with input left floating. Due to the high values of R3 and R6 the unit has a high input impedance, and these two components will have no effect on the circuit when the input is connected to a normal functioning digital output.

Some of the output signal from IC1 is coupled to TR1 base via R2 and C3, but because C3 is included the coupling is only effective on a.c. signals. This causes TR1 to become conductive on positive output half cycles, and l.e.d. indicator D1 to come on in consequence.

The display decoder and driver is a CMOS 4017 device and the clock signal is generated by an NE555 timer i.c. used in the astable mode. These are IC2 and IC3 respectively. The 4017 can directly drive the l.e.d. display and no current limiting resistors are needed. The clock enable input of this device must be connected to the negative supply rail for the device to function. The reset terminal is not needed in this application and so this too is taken to the 0V rail.

IC3 has four switched timing capacitors with S1 being used to select the desired capacitor. This provides the unit with four timebase ranges. VR1 is the timebase fine frequency control. The timebase ranges are approximately as follows: Range 1 = 5Hz to 50 Hz, Range 2 = 50Hz to 500Hz, Range 3 = 500Hz to 5kHz, and Range 4 = 5kHz to 50kHz. IC3 has to operate at ten times these frequencies.

COMPONENTS . . .

Resistors

R1	1k
R2	47k
R3	2M7
R4	68k
R5	8k2
R6	10M
R7	1k8
R8	4k7
R9	15k

All resistors $\frac{1}{4}$W 5% carbon.

Potentiometers

VR1	47k Lin. carbon

Capacitors

C1	100µ 10V elect.
C2	100n type C280
C3	100n type C280
C4	220n 5% or better
C5	22n 5% or better
C6	2n2 5% or better
C7	220p 5% or better

Semiconductors

D1	TIL211 (green) or similar with panel holder
D2	1N4148
D3 to D12	TIL209 or similar with panel holders (10 off)
IC1	CA3130T
IC2	4017
IC3	NE555 or equivalent
TR1	BC109

Switches

S1	4 way 3 pole rotary type (only 1 pole used)
S2	S.p.s.t. toggle type

Miscellaneous

Verocase type 91-2672A or similar (about 134 × 123 × 44mm).
3·5mm jack socket (SK1), 3·5mm jack plug, test lead and prods
Two control knobs
PP3 battery and connector to suit
0·1in. matrix stripboard
Sockets for i.c.s, wire, solder, etc.

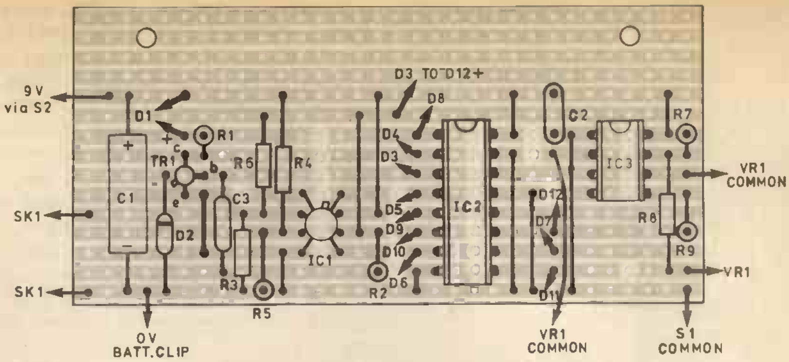


Fig. 4. Veroboard layout of the Logiscope

The timebase frequency can be altered slightly by applying a control voltage to pin 5 of IC3, and this enables a simple synchronisation circuit to be used. This merely consists of coupling one output of the display driver to pin 5 of IC3 via R9. The output voltages of IC2 are dependent to a large extent on the output state of IC1, and not just the logic state each particular output happens to be in, because none of the outputs have anything like zero output impedance. This seems to provide better sync. than is obtained by taking the signal from the output of IC1.

S2 is just an ordinary on/off control. Power is obtained from a 9V battery (PP3, etc.) and the current consumption varies between about 12 and 35mA, depending upon the timebase frequency and the state of the display.

CONSTRUCTION

The prototype is housed in a Verocase and the general arrangement of the unit can be seen from the photograph. The input is coupled to the unit via an ordinary test lead and a 3·5mm jack mounted on the front panel, but the unit could easily be constructed in conventional logic probe form if preferred.

Except for the controls and l.e.d.s, most of the components are mounted on a 0·1in. matrix stripboard which has 32 holes by 15 copper strips. C4 to C7 are not mounted on this panel, but are soldered direct to the tags of S1. All the wiring of the unit is shown in Fig. 4.

USING THE UNIT

The maximum input frequency for which the unit can display the mark space ratio depends upon what the mark space ratio actually is. It is over 200kHz for a 1 to 1 mark space ratio, but decreases with higher ratios. As a pulse detector it will operate at higher frequencies and will detect pulses of less than 1 microsecond in duration.

When the mark space ratio is fairly long it may be found that the display will indicate a mark space ratio of, say, 10 to 1 and 5 to 1, and perhaps lower ratios as well. The correct result is always the highest ratio. The lower ratios are produced by higher timebase speeds and are the result of the pulse occurring on every second, third, or fourth sweep. This makes the pulse seem two, three or four times its actual length, but this is quite easy to detect since it results in the display being noticeably dimmer than normal.

The display is not exceptionally bright because even though the l.e.d.s are pulsed with a reasonably high current, they can only be on for a maximum of 10 per cent of the time. However, the display brightness has been found to be perfectly adequate under normal lighting conditions. ★

POINTS ARISING

NOUGHTS AND CROSSES GAME *(January 1979)*

In Fig.3 IC2, 3, 4 and 5 should have pins 2 and 4 linked. IC2, 3 and 4 should have pin 5 linked to the 4k7 resistor and in Fig. 8 the emitters of TR20 and TR21 should be linked.

ADSR ENVELOPE SHAPER *(January 1979)*

The Veroboard track layout was incorrectly reversed left-to-right in this article. Constructors can obtain a correct copy of the layout diagram from the editorial office at Poole.

FRANK W. HYDE

THE DEATH OF SKYLAB

The decision by the United States to jettison Skylab is on the face of things a great disappointment. However, there does seem to be a rather emotional reaction in some quarters as to the possible damage to life. Only one publicised case is on record of possible danger from an uncontrolled satellite, which in the event proved to be a safe fall on land.

The size and weight of skylab seems to be the main cause of concern. The precision that can be applied to the tracking of the dying vehicle seems to be overlooked. Perhaps it is because of the rarity of space disaster that the media tends to become a little on the "doom" and "destruction" side of reporting.

It is perhaps worth while to consider the matter a little more closely for it is a responsibility of those engaged in these matters to be honest and factual particularly when informing the public of the exact situation. There is so much tendency with the "doom" mongers to deal in conjecture and dire consequences without the least degree of reasonable accuracy.

The condition of Skylab and its relative position has been closely observed, and with the facilities available it is possible to state almost a minute to minute re-disposition. There are certain important points that should be remembered.

The first is that the vehicle does not have protective heat shielding. Some parts of it, the panels, the telescope mounting and various external attachments will almost certainly vaporise very early in the final fall. That it will be a spectacular sight there is no doubt and even this will yield data of some significance. It is a pity that some sources have already made exact statements as to the magnitude of casualties. Though it is possible during a continuing observation to determine very accurately the likely course of events, the last moments may pose difficulties. Nevertheless it will be possible to form a workable programme of action during the event. Unless large pieces are scattered in the atmosphere as a result of explosion, possible damage may well b‹ considerably less than may be feared.

If the fall is over an ocean area then the chances of material damage becomes more and more remote. Having said that there remains one important possibility and that is the deliberate destructive action by explosive controlled (killer) satellite. If it is found that a real danger could exist, what better justification for its agreed destruction by those with the means, is needed for the common cause of mankind.

TIROS-N SATELLITE

On the 13th of October 1978 the third generation polar-orbiting TIROS-N was launched. It has already justified its planning and is giving a better insight into the workings of the stratosphere, as well as improving the meteorological forecasts. The instrument which is supplied by the Meteorological Office was the stratospheric sounding unit (SSU). It is an infrared radiometer and provides world wide data relating to the temperatures existing between the heights of 25km and 50km above the Earth. Such temperature soundings enable weather forecasting models to be made and also provide facilities for the monitoring of pollution conditions in the atmosphere.

The SSU is an interesting and efficient instrument based on techniques already demonstrated by the Oxford University Department of Atmospheric Physics which flew aboard the Nimbus-6 satellite.

The original system was developed by the Oxford group and based also on work done by Professor Smith's group at Heriot-Watt University and Professor Houghton's team at Oxford. The three channel sounder measures outgoing radiation from the atmosphere 15µm band of carbon dioxide. The radiation enters the SSU through a set of absorption cells containing CO_2 the pressure of which is varied at about 40Hz using a piston vibrating in a cylinder. The strength and the width of the absorption lines vary with pressure, thereby modulating the radiation which is emitted by the carbon dioxide.

The modulated component is received by the detectors (pyroelectric triglycine sulphate) designed and built by the Allen Clerk Research Centre. The SSU has a 10° field of view. This can be varied in 10° steps at right angles to the satellites' line of flight. Each step is viewed for four seconds which means that an area of about 150km is then covered by the 10° field of view. The distance between the adjacent scan lines is about 210km. The instrument calibrates itself at regular intervals of 256 seconds. Two reference bodies are used in the calibration mode, an internal black body and the background of space.

Marconi Space and Defence Systems is building altogether eight of the SSU's and the remaining seven will be flown aboard a series of NOAA satellites to follow the TIROS-N. Two spacecraft will be in orbit at any one time. The remaining craft will be held in store until required. Data will thus be available at least to 1985. Initially the data will be used in research into the dynamics of the stratosphere and the way in which it interacts with the troposphere. Man-made effects and natural effects will be studied in the variations of the ozone and carbon dioxide content.

Global maps will be available to other countries who ask for them. It will be possible to supply data on stratospheric behaviour within hours.

THE VELA PULSAR

A new technique to detect pulsars has been developed by a team of British and Australian astronomers at Sliding Spring Mountain in New South Wales. The pulsar which was first discovered as a radio pulsar flashing at 16 times a second in 1968 is now found also to be an optical pulsar. This neutron star is at a distance of 1,600 light years.

This new development was made possible by the installation of the 3·9m telescope. The pulsar is estimated to be about 10,000 years old. It is the second fastest pulsar known. It never completely turns off but settles to a steady state. It has a pattern of double flashes every 89ms. By using a time interval succession of pictures of 33ms interval the flashes can be caught in the on and off state.

The previous telescopes were not of sufficient light gathering power to detect the pulsar. The operation of this pulsar is similar to a lighthouse, there being one main pulse followed by the secondary pulse.

HOLOGRAPHY IN ASTRONOMY

New techniques of mathematical analysis have been developed by Dr Gerd Weigelt of the University of Erlangen-Nurnberg in Germany. They enable speckle interferograms of stellar objects to be made. The speckle interferogram is a very short exposure of a stellar object, which freezes the star image dancing because of the turbulence of the atmosphere. Already 240 speckle interferograms have been made. The telescope used is 1·8m in diameter.

VENUS

The unexpected result of the Venus multiprobe experiment was an indication of large quantities of Argon-36. By comparison with the Earth this is so high as to give cause for a very special look at the present theories of the origins of Venus. That the planets Venus and Earth evolved at about the same point in time seems to be in doubt with some planetologists.

Till now it has been thought that the primodial argon was blown away at a very early date in the lifetime of the two planets. The discrepancy that exists between Mars and the Earth was explained by saying that as Mars was a smaller planet less gas was released. Whether these sudden changes in the situation are thought to exist is to some extent in doubt because the results of the mass spectrometer differ by a factor of 10 from the results of the gas chromatograph on the probes. This alone should warn against hasty judgements. It may well be that still another mission will be required before any radical ideas can be allowed to prevail.

IN recent months the use of digital sequencers with music synthesisers has become very popular with contemporary music and completely new sound patterns have been created with these devices.

A sequencer enables the user of a synthesiser to program in voltage patterns that in turn produce a musical melody which can be further manipulated in terms of speed, rapid key changes, etc. all of which would be very difficult, if not impossible, for the human operator to do with such speed and precision. For example, a drum sequence can be programmed into the sequencer and replayed while the musician plays the synthesiser or other instrument.

16 NOTE SEQUENCER

PART ONE...LYNDSAY ROBINSON

SEQUENTIAL CONTROL

The sequencer to be described in this article enables up to sixteen different bits to be programmed and repeated at any speed required. The sixteen bits to be programmed and repeated at any speed required. The sixteen bits can refer to pitches, as is most common, or the timbre, loudness or length of the musical note. The notes are programmed into the sequencer by the use of potentiometers, one for each note. This is the method of sequential control most commonly adopted by all the main synthesiser/sequencer manufacturers, Moog, ARP and Roland for example.

While it may appear a rather simple and crude method of achieving a sixteen note memory compared with all the digital memories available, it is the cheapest and most reliable method as the tuning potentiometers used will remember indefinitely the selected voltage level.

Bearing in mind that the previously mentioned commercial sequencers cost several hundred pounds, the sequencer to be described has features as found on these designs and will cost around £35 in components and hardware.

The method used to generate the sequential function is simply an oscillator driving a digital counter with the output voltages going through a potential divider to obtain the processed voltage. This voltage then controls the frequency of a voltage controlled oscillator, or the cut-off frequency of a voltage controlled filter or the attenuation of a voltage controlled amplifier in the synthesiser.

A prototype sequencer has been used very sucessfully with a Mini-Moog synthesiser and the advanced features available on commercial versions are possible at a much reduced cost.

The basic layout of the sequencer is as shown in the block diagram (Fig. 1) and each block will now be considered in detail, referring to the appropriate circuit diagram.

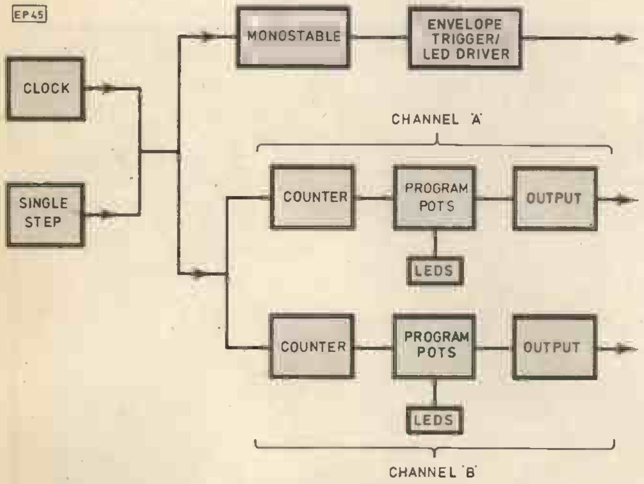


Fig. 1. Block diagram

SPECIFICATION . . .

Sequence Channels

(a)
- (i) one channel of up to a maximum of sixteen programmable voltage levels
- (ii) two channels of up to a maximum of eight programmable voltage levels
- (iii) a 64 note sequence can be programmed (eight groups of eight notes)

(b) two, eight-way switches select the number of notes in each sequence channel

(c) the two counters (sequence channels) can be advanced by:
- (i) integral clock oscillator
- (ii) push button
- (iii) external input pulses

(d) reset push button

(e) pulse output available from jack sockets at end of sequence

(f) channel one, position one pulse output

(g) single or repeating sequences possible

Clock

(a) frequency range of approximately 0·2Hz–100Hz

(b) voltage controllable frequency

(c) clock can be switched off/on by manual switch or be gated off/on via jack socket

(c) output from clock is directed to:
- (i) counters
- (ii) output trigger circuit

Envelope Shaper Trigger

(a) variable pulse width to trigger either AD or ADSR envelope shapers, pulse time approximately 50mS–4S

(b) positive trigger level 0–9V

(c) L.e.d. shows on period of monostable

Sequential Analogue Outputs

(a) voltage levels programmed by 16 potentiometers, typically 0–6V output (12V max)

(b) master output controls for each channel

(c) low output impedance

(d) variable portamento (slew) on channel one output and 16 bit sequence

Lamp Indicators

(a) L.e.d. for each note of each channel to show progress of sequence (total 16)

(b) L.e.d. showing on period of envelope trigger

Power Supply

±12V for sequencer; can also be used to power additional synthesiser functions

CLOCK GENERATOR

IC1 is the control voltage adder for the voltage controlled clock (Fig. 2). R4, D1 and D2 protect the CMOS device from voltages more negative than 0V.

By applying a voltage to the gate of the *n*-channel MOSFET the resistance between the source and the drain will decrease with an increasing gate potential. This resistance is used as the timing resistor in the oscillator consisting of the two NOR gates in IC2.

The frequency of oscillation can be varied from about 0·2Hz to 100Hz by adjustment of VR2. The two preset resistors are adjusted so that VR2 will produce this variation.

The clock can be gated on or off by S1 or by a control voltage applied at JK1. The squarewave output is then inverted by part of a 4007 so that when the clock is gated off, the output is low. The remainder of the NOR gate is used to construct a latch for bounce-free operation of S2 which is a single step control and will advance the sequencer counters by one position each time.

MONOSTABLE TRIGGER

A monostable is seen after the inverter. A pulse of constant period is produced by C3 and R14 and this is used to switch an *n*-channel MOSFET which in turn is used to discharge the capacitor C2. Pins 5/6 of the AND gate will normally be at logic "1" and after a time period set by R10/VR4 and C2 the potential will fall to 0V.

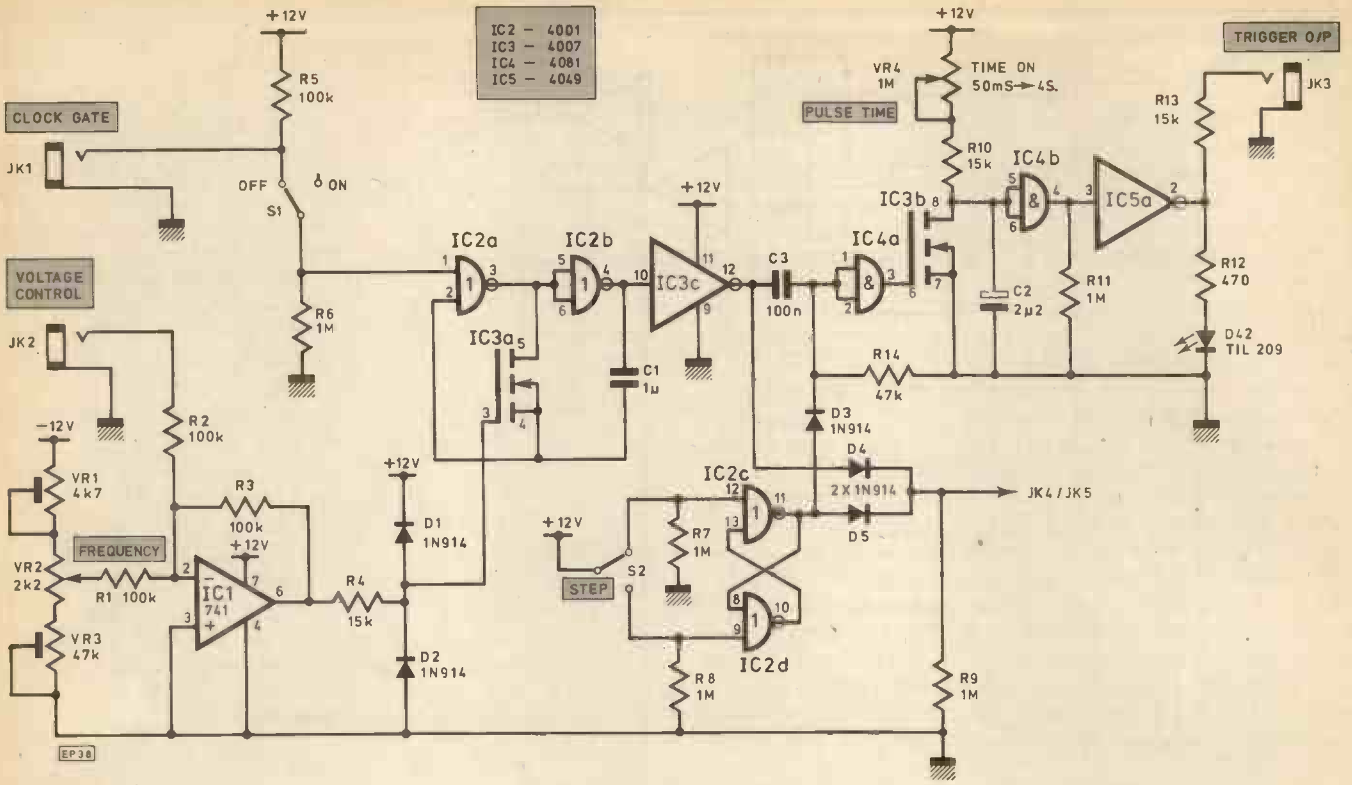


Fig. 2. Sequencer front end

COMPONENTS . . .

Resistors

R1–R3	100k
R4	15k
R5	100k
R6–R9	1M
R10	15k
R11	1M
R12	470
R13	15k
R14	47k
R15–R17	10k
R18–R33	680
R34–R40	100k
R41–R44	470k
R45	240k
R46	1k

All ¼W carbon-film

Capacitors

C1	1µ non polarised
C2	2µ2 16V elect.
C3	100n
C4–C7	1n
C8	2µ2 16V elect.
C9–C10	1,000µ 25V elect.
C11–C12	1µ 16V tantalum

Bridge Rectifiers

REC1–REC2	1A 50V (2 off) (W005)

Integrated Circuits

IC1	741
IC2	4001A
IC3	4007
IC4	4081B
IC5	4049B
IC6–IC7	4017A
IC8–IC9	4049B
IC10	4001
IC11	4016
IC12–IC14	741
IC15–IC16	LM341P–12

(12V 500mA positive regulators)

Potentiometers

VR1	4k7 preset
VR2	2k2 linear
VR3	47k preset
VR4	1M linear
VR5–VR20	100k linear
VR21	1M linear
VR22	1k linear
VR23	1k linear

Diodes

D1–D25	1N914
*D26–D42	Large red l.e.d.s plus clips

Switches

S1	s.p.s.t.
S2	s.p.d.t. spring biased
S3	Push to make
S4–S5	Single pole, eight-way rotary with end stop
S6	d.p.d.t.
S7	d.p. mains switch

Transformer

T1	0–12V 0–12V 6VA (Maplin)

Miscellaneous

JK1–JK3	3·5mm jack sockets
JK4–JK7	3·5mm jack sockets with closed contacts
JK8–JK10	3·5mm jack socket

14 pin i.c. sockets (5 off)
Thin eight-way ribbon cable
Graduated knobs (16 off)
Plain knobs (7 off)
Letraset, p.c.b., FS1 100mA 20mm fuse.

LP1	neon indicator

VR5–VR20

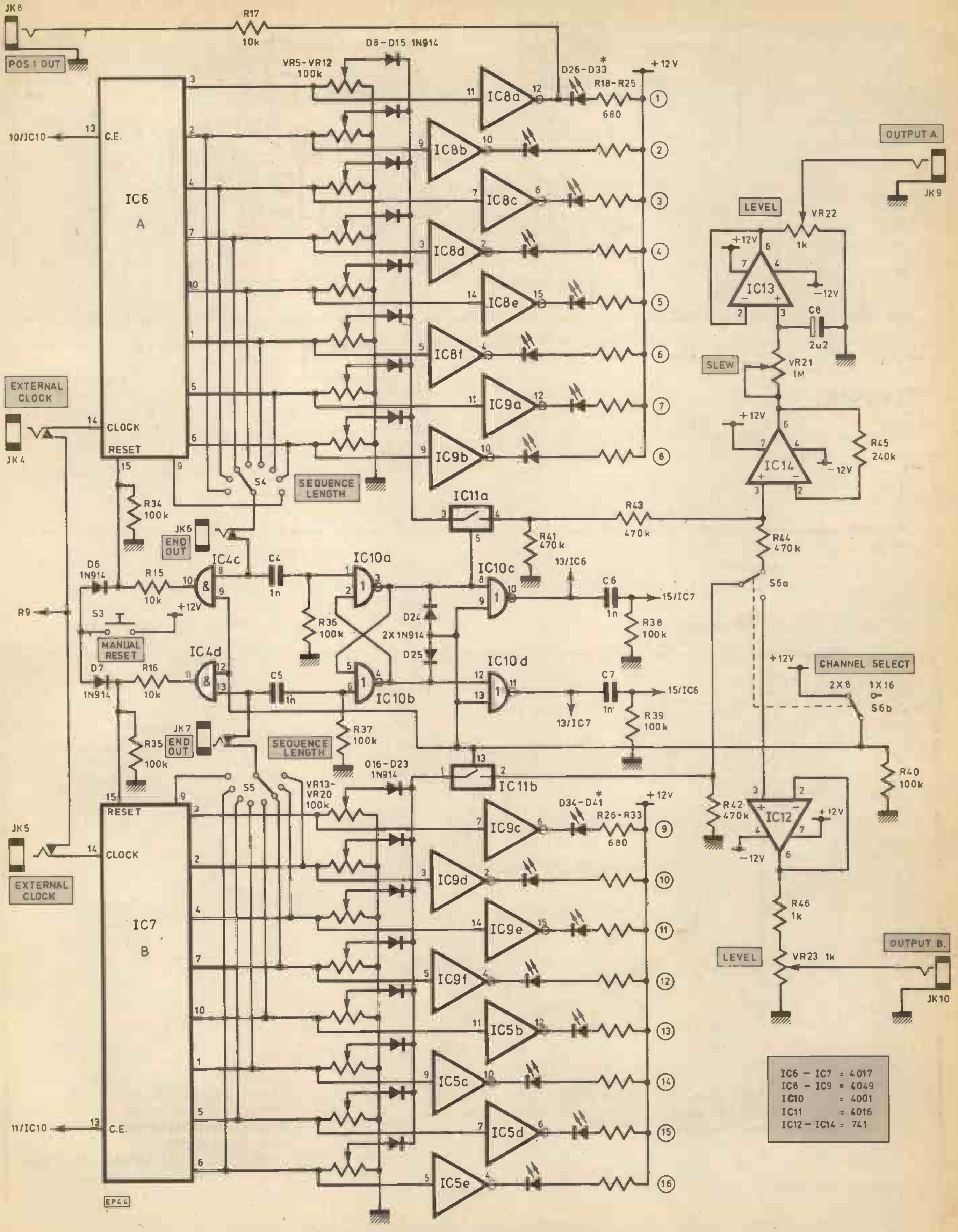


Fig. 3. Counters, channel switching and output stages

16 note sequence

	4001 pins			
	3/5	2/4	1	6
A run, B stop	1	0	0	0
B reset, B run	0	1	1	0
B run, A stop	0	1	0	0
A reset, A run	1	0	0	1
Repeat	1	0	0	0
etc.	0	1	1	0

Logic 0 = 0V   Logic 1 = 12V

Counters enabled—0
Counters stopped—1
Counters reset—1
Counters run—0

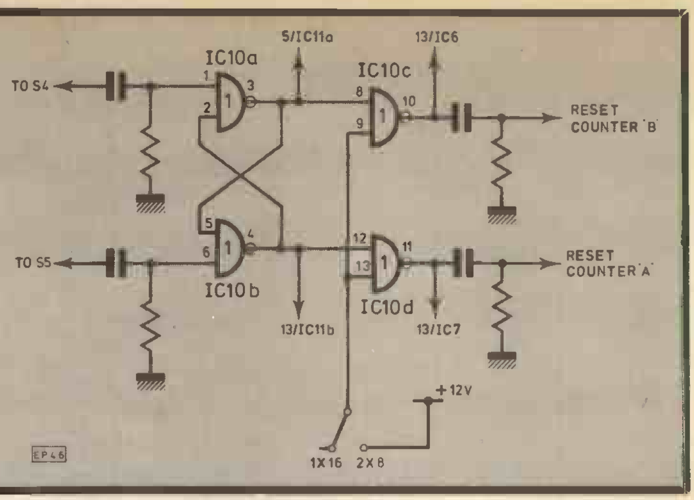


Fig. 4. Showing logic for 16 note sequence. For 2 × 8 sequence the latch is bypassed (IC10a/b). Each counter resets via IC4c/d

TAPPED VOLTAGES

Each sequential output (only eight are used per channel in this sequencer) is terminated by a 100 kilohm potentiometer which is used to tap off a precise voltage to control a VCO in the synthesiser. The outputs from the counter are also used to control the 4049 hex inverter buffers which are used to drive the l.e.d.s. For this purpose the new CMOS series of "B" devices is used. The RCA 4049B can sink up to 42mA at 12V per package and this is adequate for the sixteen l.e.d.s, one for each note, since there is a maximum of only three l.e.d.s being driven at once (including the envelope trigger l.e.d.).

This voltage is inverted by an inverter in IC5 and a positive pulse will be formed each time the MOSFET is turned on. The pulse, of period from 50mS to 4S, is used to trigger the envelope shaper in the synthesiser, and for an AD type this trigger will correspond to the sustain time, and for an ADSR type of envelope shaper, this represents the time the keyboard note is depressed. An l.e.d. lights to show the "on" time.

CHANNEL COUNTERS

The output from either the clock, the "single step" or external pulses via JK4–5 is used to advance the CMOS counters (Fig. 3).

The 4017 is a decade counter which will decode a series of clock pulses into a sequential output. A "counter enable" terminal, pin 13, is used to inhibit the counter by application of logic "1". A "reset" terminal, pin 15 will cause the counter to be reset when "1" is applied.

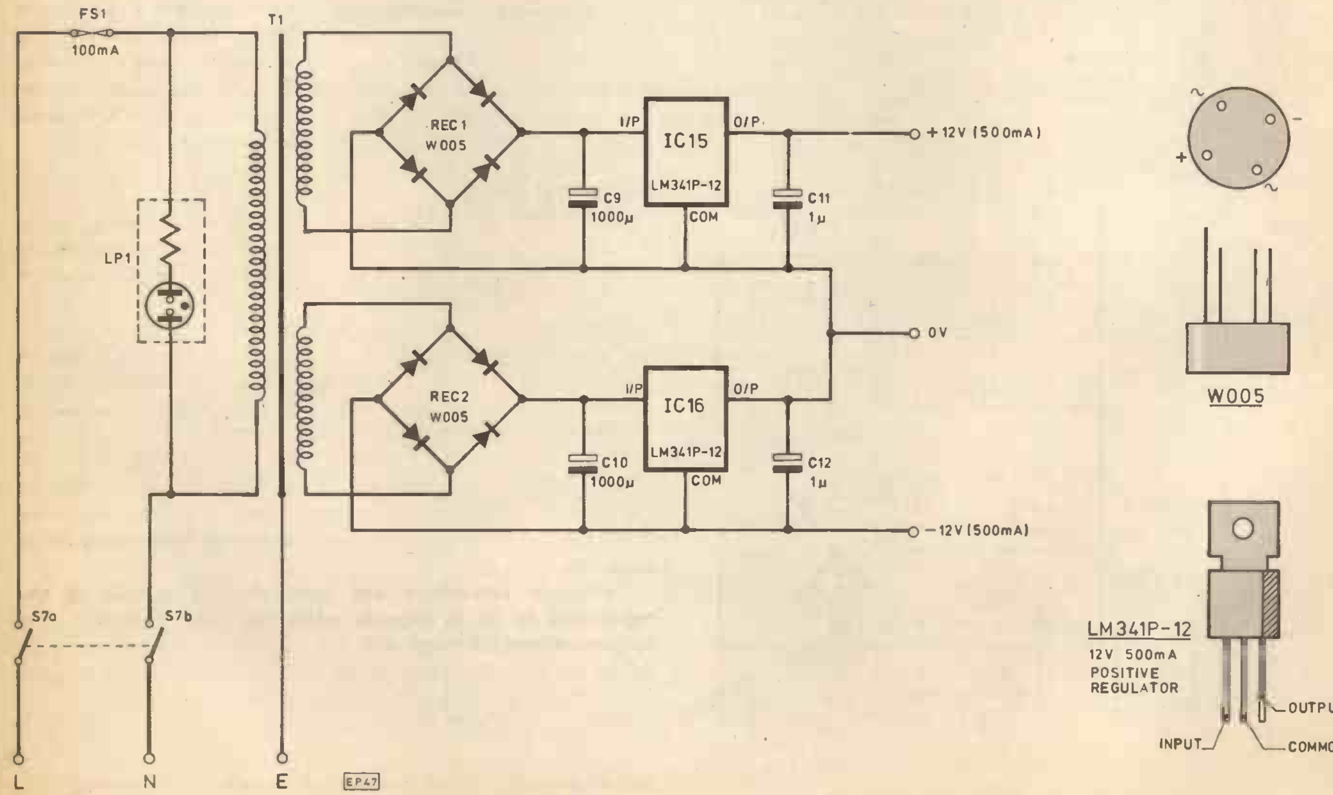
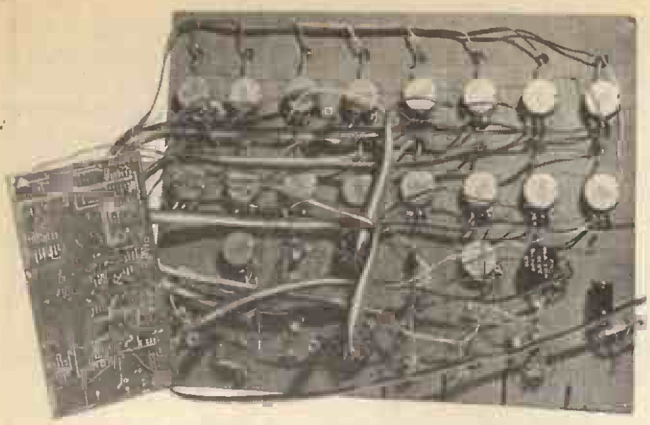


Fig. 5. Sequencer power unit



Sequencer interior

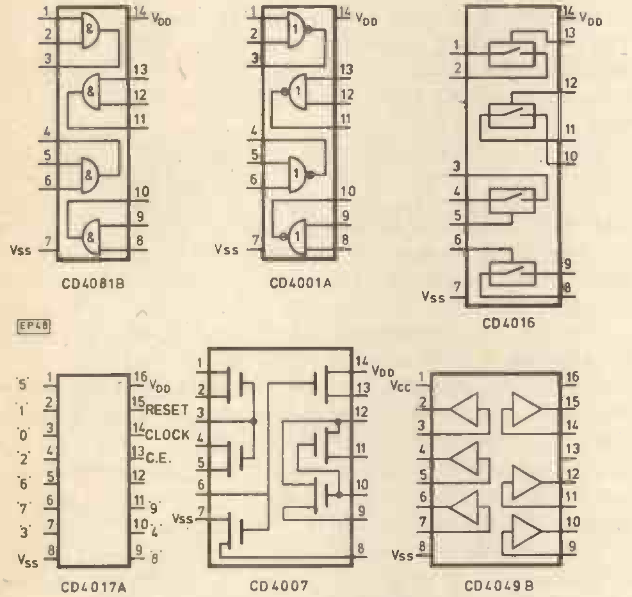
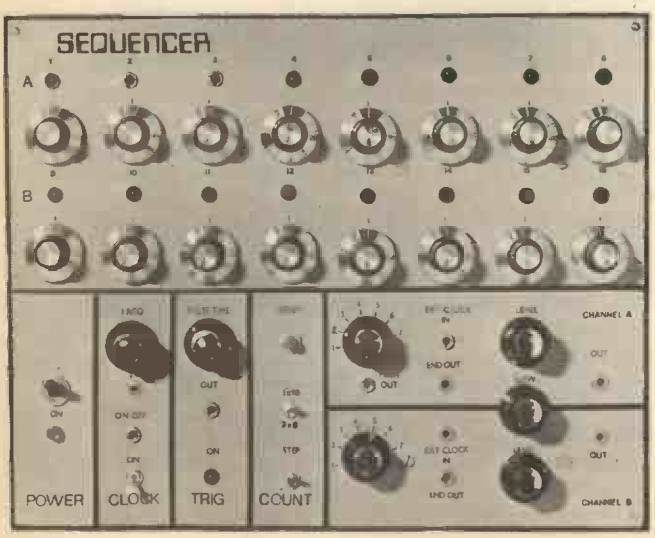


Fig. 6. I.c. pin-out details



Control panel

The channel outputs from each of the programming potentiometers, passes through IC11, which is an analogue switch, and depending on the channel switching as controlled by IC10, the signal passes through to the 741 op-amp voltage adder.

Previously, each of the pot outputs is taken to the analogue switch via isolation diodes to prevent a programmed pot that is low, from lowering the potential of all the others.

Normally counter A only uses IC14 when the sequencer is in the parallel channel mode (2 x 8 channels operating simultaneously). But channel B is switched in for a 16 note sequence and the analogue switch and IC10 are used for this function.

IC13 is used to add a variable portamento to the sequence in the 16 note position and channel A only when the sequencer is used in the parallel channel position.

The voltage outputs from the channels are reduced to 6V maximum for convenience when used with a synthesiser, but by adjustment of R45 and R46 this can be altered.

CHANNEL SWITCHING LOGIC

The channel selection logic is shown in greater detail in Fig. 4. Such complexity is necessary for easy switching between series and parallel counter function, and also to ensure that the full number of counts is produced by each channel as originally selected by the "Sequence Length" rotary switch. It is also necessary that when a counter is at that instant not in use the l.e.d.s for that channel have stopped.

In the parallel mode, the sequential counters are reset via the AND gate and function completely independently, e.g. one channel can be used to produce a four note sequence, and the other an eight note sequence. None of the gates of IC10 are used and this is bypassed by the NOR gates in the remaining part of the i.c. and the counters are continually enabled.

In the series position, when one counter, say A, has come to its last count the latch is changed over and counter B is simultaneously reset and enabled. Counter B will then run to the last count as selected by S5 and the latch will be changed over again; counter B disabled, counter A enabled and reset. This continues for as long as necessary.

POWER SUPPLY

The power supply for the sequencer is shown in Fig. 5 and is based on positive voltage regulator i.c.s. The circuit will provide $\pm$12V at 500mA and can be used to power other sythesiser modules.

The circuit is designed around two positive regulators rather than a positive and negative regulator, since these are more readily available and cheaper, and this system requires the use of a transformer with separate secondary winding, available from Maplin or R.S. Components.

If the power supply is only to power the sequencer—no other synthesiser modules—then heatsinks will not be necessary, otherwise for the full power output adequate heatsinking must be used, and the transformer must be as specified.

Tantalum capacitors are used on the output of the regulators so as to provide adequate ripple rejection. The sequencer circuit itself will not malfunction, but the ripple could be superimposed on the sequential voltage outputs and hence the VCOs, etc. and be reproduced audibly.

Next Month: Constructional details and using the sequencer.

BINAURAL STEREO PATENTS

ADRIAN HOPE

THE BBC has recently transmitted several plays in binaural, or so called "dummy head", stereo and several commercial recordings have been issued to demonstrate the technique. Although binaural stereo is in fact an extremely old idea (just how old will subsequently emerge) there is still widespread confusion over what it is, how it works and what it offers.

The situation has not been helped by the rather inadequate press releases issued by the Broadcasting House Publicity Departments prior to the BBC binaural transmissions. These releases have been garbled by innocents in the national press with the result that many people who are in fact fully equipped to listen to binaural stereo radio transmissions may well not have realised the fact and thus missed opportunities.

CURRENT INTEREST

The current wave of interest in binaural stereo dates back to a demonstration given by the German firm Sennheiser at the Berlin radio exhibition in 1973. Soon afterwards, the test disc recording which was made for Berlin was used by the British magazine *Wireless World* for a small, almost casual, demonstration at the Olympia audio fair. First word of mouth, and then press enthusiasm, spread the news that binaural stereo reproduction can create far more effective surround-sound reproduction than any quadraphonic or surround-sound loudspeaker system yet available.

The theory behind binaural stereo recording and reproduction is simple. Humans hear with two ears and are able to pinpoint the origin of a sound with remarkable accuracy, even with eyes closed. This is achieved thanks to the effect which the human head has on any sound arriving at both ears from a single sound source. Essentially the head serves as a baffle. When the arriving sound is of low frequency (a few hundred Hz) the head baffle has no discernible effect on the amplitude or volume of sound arriving at each ear. But it does have a discernible effect on the relative phasing of the long wavelength of the low frequency sound. When the pitch of the arriving sound rises, the head baffle has less discernible effect on the relative phase of the sounds. This is because the shorter the wavelength, the more anomalous the phasing becomes and the extra distance which the sound must travel between the two ears becomes less significant. But at these higher frequencies the head can attenuate the volume of the sound arriving at the furthest ear.

In other words the head acts as a potential obstruction to the sound arriving at each ear and this obstruction creates anomolies in either phasing or amplitude, depending on the soundwave frequencies and their direction of arrival. The human brain is remarkably adept at decoding these anomolies to pinpoint the sound source.

If a pair of omni-directional microphones are arranged one in each ear of the human head, or an imitation or dummy head which closely resembles the human head in shape, size and texture, then what the microphones capture is a reasonably accurate replica of the sound field at each ear. If the left and right ear replicas are recorded on the two tracks of a stereo tape recorder and replayed through an amplifier and stereo headphones, then the headphone listener will hear a reasonably accurate replica of what the ear microphones heard.

Although the system is not perfect (there may be difficulties in distinguishing front from back sounds) the headphone reproduction of a binaural (i.e. two eared) recording made using either a dummy or live head to hold the microphones, can produce a remarkable spread of sound all around and over the head of the listener. There is no real way of describing the effect, one can only recommend that anyone with a stereo hi fi system and a good pair of stereo headphones should listen either to a binaural stereo recording or a BBC binaural stereo transmission.

PATENTS

As so often happens, the history of binaural stereo and likely future developments are well documented by patent literature.

In 1881 Frenchman Clément Ader, who was fascinated by both aeronautics and telephony, arranged a demonstration at the Paris Electrical Exhibition to put the Bell telephone through its paces. He arranged eighty Bell telephone mouthpieces or "transmitters" across the front of the Grand Opera stage in Paris and connected them by hard wiring to eighty earpieces or "receivers" in the Exhibition Hall. The object was of course to demonstrate what was then regarded as high fidelity reproduction of sound by telephone wire communication. But listeners found that by using two earpieces instead of one they achieved a remarkably realistic image spread of the opera sound. They were, without realising it, discovering binaural stereo reproduction.

Until evidence to the contrary is produced it seems safe to take the next and most positive emergence of binaural stereo, as the patent application filed on April 13, 1927 by W. Bartlett Jones of Chicago. The patent was not granted until 1932 and carries the American number USP 1 855 149. It is still available for the public to read in the library of foreign patents attached to the British Patent Office in London.

Bartlett Jones was aiming to improve the reproduction of sound from recordings, for instance in a cinema. His experiments with a dummy head equipped with a microphone in each ear and connected to a pair of small speakers arranged as headphones one each side of a listener's head, convinced him that "a richer and more sonorous reproduction" than was obtainable from an ordinary phonograph was a practical possibility. Jones envisaged the idea of reproduction not only through headphones but also by a pair of loudspeakers "embodied into or secured to a seat so as to direct a right ear effect and a left ear effect to the seat occupant".

Last year at the Harrogate Hi Fi Festival one firm was demonstrating the modern equivalent of just such a seat, a lounging-all-enveloping chair with loudspeakers built into the side walls. Incidentally Jones in 1927 also proposed a technique of binaural stereo *recording* by cutting two grooves in a single disc or modulating a single groove both vertically and horizontally. He was certainly one of the forgotten audio pioneers.

It seems likely, from a reading of Bartlett Jones's patent, that the results he was obtaining from hard wire connections (it is doubtful whether he succeeded with recording) were comparable to those obtainable today from a lo fi system. Certainly a binaural system was installed in the Chicago Science Museum in the thirties and offered continual demonstrations to enthusiastic audiences.

One visitor recalls how the audience would be equipped with headphones through which they heard an announcer in a transparent soundproof booth talking into a dummy head microphone system. Half way through the demonstration each visitor heard an unfamiliar voice whispering in their left ear. "Could you please move a little to the right, you're blocking my view," said the voice. Like a field of corn every visitor, imagining that they were blocking the view of the listener behind, moved to the right.

LOUDSPEAKER STEREO

Why then did dummy head, or binaural, stereo not catch on permanently? Why was it forgotten again until the seventies? To answer the second question first, binaural stereo has never been entirely forgotten. Over the years, especially in the USA, there have been various test or demonstration recordings issued for minority interests. The answer to the first question lies again in the patent literature. In the early thirties Alan Dower Blumlein, working at EMI Hayes on improved sound reproduction, patented a system for reproducing stereo with a pair of loudspeakers in a room rather than a pair of headphones or a pair of loudspeakers in a chair.

The British patent number BP 394 325 (also still readily available) is perhaps the most famous audio patent of all time. It discloses in detail schemes for recording and reproducing sound in stereo using a coincident pair of microphones and spaced loudspeakers, with the sound recorded either in a double modulated disc groove (in the manner of every LP stereo disc now on the market) or on an optical film soundtrack (as now finding favour in Hollywood with films like *Star Wars*, *Close Encounters* and *Grease*). What Blumlein was aiming for, and achieved, was what we now call "stereo" reproduction without the anti-social limitations of headphone listening. In this respect he was too far ahead of his time.

The war years hampered progress and diverted public interest. But when the idea of stereo reproduction started to interest the trade and public again after the war, it was hardly surprising that the promise of reproduction with a pair of spaced loudspeakers in Blumlein fashion should capture the public imagination, rather than lonely reproduction by means of headphones or a loudspeaker chair. So loudspeaker stereo, not binaural headphone stereo, became the commercial norm—and still is.

SURROUND-SOUND

It was the upsurge of interest in surround-sound reproduction, and the various quadraphonic systems devised in an attempt to reproduce sound around the listener in a room, that set the scene for a major re-emergence of binaural stereo. Quite simply none of the quadraphonic systems foisted on the public in the early seventies could achieve what they set out to achieve, namely a true surround of sound around the listener. When Sennheiser demonstrated their first dummy head test disc (still obtainable from Hayden Labs, the British agents for Sennheiser at around 75p) the time was absolutely right for a rediscovery of binaural stereo. An ordinary stereo disc played on an ordinary stereo turntable through an ordinary stereo amplifier and through ordinary stereo headphones delivered far more than even the most sophisticated quadraphonic system. There are now several hi fi firms offering do-it-yourself binaural stereo recording kits, usually a dummy head with a pair of small capacitor microphones fitted to fit the ears. Sometimes the microphones are built into headphones, sometimes they can be worn in the ears of a human.

The over-riding disadvantage of binaural stereo is that a recording made in this fashion will produce the required result *only* when reproduced over headphones (or in a loudspeaker chair). The reason is obvious although repeatedly overlooked and misunderstood. In *loudspeaker* stereo reproduction the sound from the left speaker reaches *both* the left and right ears of the listener, and the sound from the right speaker reaches *both* the right and left ears of the listener. Also the sound is transferred to the listener via the room acoustics. Most normal recordings are made in a manner which presupposes that reproduction will be in this way and the entire chain of recording and room reproduction produces an illusion of a sound spread between the loudspeakers. When heard over headphones a recording made for loudspeaker reproduction will usually sound flat, as if coming from inside the listener's head. This is because there is direct interface between the headphones and ears.

A recording made with a dummy head and intended for *headphone* reproduction will produce a quite unsatisfactory stereo image when reproduced from loudspeakers. True binaural reproduction effect is only obtained when the sound picked up by the left ear microphone is channelled or interfaced only to the listener's left ear, and so on. When a binaural stereo recording is reproduced from loudspeakers, the sound picked up by the dummy head left ear will be reproduced by the left loudspeaker but will reach *both* the left and right ears of the listener, and so on. It will also be coloured by the room acoustics through which it travels. The result is a diffuse and confused stereo image. Loudspeaker and binaural stereo recordings are thus *not compatible*.

MODIFIED SYSTEMS

This incompatibility has prompted research all round the world to develop modified systems. In 1974 Herr Stahl of the German radio station RIAS, lectured broadcasters in London on how dummy head recordings can be doctored to make them compatible for loudspeaker reproduction. Essentially the undesirable acoustic crosstalk between left loudspeaker and right ear, and right loudspeaker and left ear, is cancelled. This is achieved by introducing phase shifts and delays into both sound channels.

A degree of frequency equalization is also used to compensate for, i.e. subtract, the effect of the acoustic transfer of the sound to the ears of the listener via the room rather than by direct interface between the headphones and the ears.

Shahl at the time stated that "the amount of electronic equipment required . . . is considerable . . . but with integrated circuits . . . manufacture would not be too expensive". Such manufacture is now under way in Japan. One of the firms especially active in the field of binaural stereo reproduction is Matsushita. There are already on sale from JVC and National (so far in Japan only) add-on "black boxes" which doctor stereo signals so that they can be reproduced by loudspeakers with impressive binaural results. But listener position is *very* critical.

A Dutch inventor by the name of Johannes Van Den Berg recently patented in the UK (BP 1 503 400) an alternative approach to the problem which relies far less heavily on sophisticated electronics. Whether the Dutch idea works in practice is open to question but the theory is interesting.

Van Den Berg suggests that the original dummy head recording should be made with two dummy heads, rather than one. The two heads, each with a microphone in each ear, are set in front of the sound stage to be recorded a few metres apart, rather like two members of an audience on opposite sides of the stalls. The sound signals from the four microphones are channelled into stereo. The left ear signals from one head are mixed with the left ear signals from the other head to produce the left channel and the right ear signals from one head are mixed with the right ear signals from the other head to produce the right channel.

In this way the left channel output of the total system contains sound from both the extreme left of the sound stage and the centre of the sound stage, while the right channel output contains sound from the extreme right of the sound stage plus sound from the centre of the sound stage. According to the inventor the stereo output provides good results both with headphones and through a stereo pair of loudspeakers. Whether the inventor is right in claiming that "sound thus reproduced via loudspeakers gives the listener a considerably better spatial impression than sound reproduced by conventional techniques" must remain a moot point.

RECENT PATENTS

Patents recently granted to Matsushita in the UK show that the company is addressing itself not only to the enhanced reproduction of binaural recording with loudspeakers, but also to a closely related problem. This is how to improve headphone listening, especially with recordings intended for loudspeaker reproduction.

In BP 1520 612 three Matsushita inventors suggest that the characteristic "in the head" sound obtained from playing conventional stereo recordings over headphones is due to the lack of indirect or ambient sound heard by the listener. This point is also emphasised in a Matsushita paper in the Audio Engineering Society Journal for November 1976. The contention is that stereo recordings will sound dead and "inside the head" when replayed over headphones if they lack ambience or indirect sound. According to Matsushita, loudspeaker reproduction adds ambience from the listening room to such recordings, but normal headphone reproduction cannot of course add any such ambience. Thus, they say, the cure for "in the head" sound from headphones is to add artificial ambience or indirect sound to the signals to be reproduced.

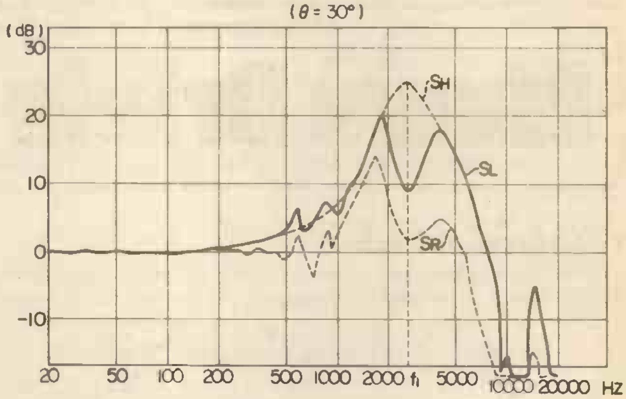
It is certainly a fact that most modern recordings are made with close microphone techniques and added artificial reverberation and that these sound dead and "in the head" through headphones. It is also true that a good dummy head recording and a good recording made with a simple coincident microphone pair (suggested by Blumlein in the thirties and still thankfully finding favour with some recording engineers) do contain a considerable amount of natural ambient information and do sound "out-of-the-head" on headphones. Although Matsushita do not follow the train of thought, it may well be that our ears and brain are able to distinguish between natural ambience and un-natural added reverberation in a recording, rejecting the latter for the artifact that it is.

The Matsushita patent proposes that the sound of a conventional, dead stereo recording may be improved over headphones by introducing extra reverberation in mechanical manner. Essentially a mechanical spring is incorporated in the acoustic transmission path to the listener's ear. This introduces an artificial reverberant delay. The system sounds primitive and self-defeating in that the ambience added must surely be as unnatural as that already present in the recording. Certainly, and perhaps not surprisingly, there is no sign yet of such an acoustic ambience-adding system in the shops.

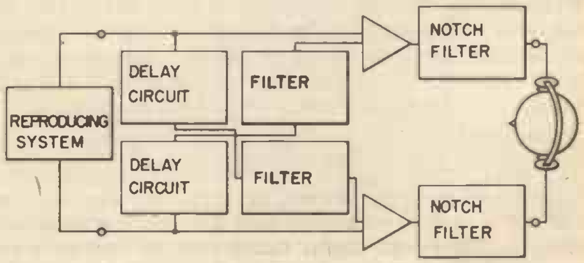
The approach suggested in the 1976 AES paper is much more encouraging, and indeed is now on demonstration in Japan. Instead of using a mechanical or acoustic circuit to add ambience or indirect sound artificially, an electronic circuit of bucket brigade devices is used to achieve the same object.

DIFFERENT SOLUTIONS

The same problems, but rather different solutions, are described in another recent Matsushita patent BP 1 517 938. Indeed this patent reads almost as if the issue of indirect sound and ambience has been forgotten by the Matsushita research department! "In the head" imaging is blamed partly on an abnormal sound pressure-versus-frequency characteristic which is created when recorded sound signals are delivered to the listener's ears with the intended acoustic link (loudspeaker-to-ear) "short circuited" by the use of headphones.



The patent includes graphs which show how sound pressure-*v*-frequency characteristic measurements taken at the ears of a listener, first facing a pair of loudspeakers in a room, and then hard against a pair of hi fi headphones, do not match. The curves suggest that there is an un-natural peak introduced by headphone listening at around 3 kHz and the Matsushita patent proposes the incorporation of notch filters in the headphone circuitry to iron out this peak. The patent also lays blame for in-head imaging on the lack of acoustic crosstalk between left and

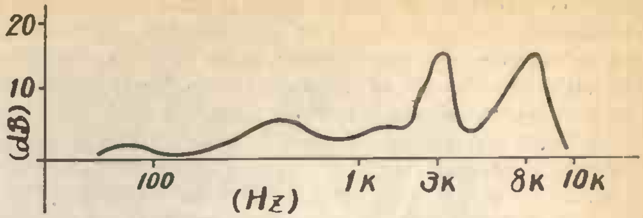


right channels when reproduction is through headphones rather than loudspeakers. To compensate for this Matsushita introduce electronic crosstalk (at low frequencies) between left and right channels. Additionally a slight delay is provided to simulate the slight delay which is introduced by the spacing of a pair of loudspeakers in front of a listener in a room.

SONY

Although there is of course some common ground between the theories proposed by Matsushita in the two patents and the AES paper, there is equally clearly no concerted agreement, even between workers in the same research lab, on how to tackle the single most important problem of headphone listening—how to ensure that the image is formed outside the listener's head, regardless of programme material. Moreover two patents recently granted to Sony, another Japanese electronics giant interested in the same field (BPs 1520 318 and 1 520 319) confirm that there is still plenty of room for dispute over the right approach to the problem.

Both Sony patents are concerned mainly with fairly trivial advances, for instance the incorporation of a miniature microphone in a headphone-like windshield for a dummy or human head to wear, and the incorporation of even more miniature microphones into windshield-like ear plugs for similar use. But both patents refer also to the loudspeaker reproduction of binaural stereo recordings. According to Sony when microphones at the ears of a human or dummy head receive sound from the front, the ear's physical structure produces peaks in the frequency response at 3kHz and 8kHz. These anomalies, according to Sony, help the listener to identify the source of sound and must be preserved in a binaural recording used for headphone listening. But when the binaural recording is



reproduced by loudspeakers in a room, the peaks will be artificially boosted because they are in effect created twice, *once* by the dummy head recording process and *once* by the real head listening process. Thus, say Sony, the frequency characteristic of a binaural recording intended for loudspeaker reproduction must be flattened with filters notching at 3kHz and 8kHz. But wait a minute? Doesn't Matsushita patent the apparently contradictory idea of flattening a 3kHz peak for *headphone* reproduction of a recording? You pays your money and you takes your choice of interpretation!

One thing is certain. There is a considerable amount of research and development work yet to be done before the public is offered what has so far proved a chimera, namely a "black box" capable of making all kinds of loudspeaker stereo and binaural dummy head stereo recordings mutually compatible for either loudspeaker or headphone listening. ★

News Briefs

AWAY WITH CONTACTORS

IF YOU'VE ever tried to service an electromechanical timer unit, perhaps on a cooker or automatic washing machine, you've probably cursed. If you've had a vacuum cleaner switch jam up, or watched your freezer motor *(relay operated)* shake because it was switched *off* at the peak of the mains cycle, or dim the lights because it switched *on* at a peak, you've probably mumbled something about . . . "the sooner springs and contacts are banished from domestic appliances the better".

It's even more baffling to anyone with the slightest involvement in electronics, that solid state devices are not widely used, since there's nothing new, or expensive about triacs.

Fortunately solid state technology *is* advancing into this domain, and one arrival is the MOS-LSI microcircuit appliance timer by G.I.M., comprising central processor with on-chip memory.

The circuit (basically a 4-bit microprocessor) is essentially a versatile, low cost timer, providing designers with the type of facilities necessary for controlling cookers, driers, central heating, etc. The 28-lead version designated AY-3-1250, accepts instructions from "hours up", "hours down", "minutes up", or "minutes down" keys, where momentary depression of keys cause single increments or decrements, and continuous depression causes the displayed digits to cycle. In use, the circuit is linked to a 4-digit l.e.d. display indicating any function selected. It has three separate outputs for which on and off times may be programmed in.

The 40-lead version—designated AY-3-1251—is designed for more sophisticated systems where 10 × 4 keyboard or touchpad entry and 14-digit permanent display are required. It has four controlled outputs, each with a variable mark-space ratio for control of hotplate duty cycles, etc. The 14-digit display facility could be used for a minute minder (3 digits), oven temperatures (3 digits), time on/off (4 digits), and hotplate temperature (4 digits).

When used for fully automatic cooker control, the time programme would be entered and cooking temperature selected using a key pad. When the start time is reached the appropriate output would be activated and an "ON" indicator lamp energised. When the stop time is reached the output is deactivated and the minute minder audible alarm activated for 10 seconds. All three programmable outputs may be separately controlled in this way, but the device can also be used in a semi-automatic or manual mode. A further facility allows a set programme to be repeated at 24 hour intervals by the simple depression of a "repeat" key.

Both 28-lead and 40-lead versions include a built-in standby frequency source, which allows the devices to function normally during mains failure. In this event the circuit detects the absence of 50/60Hz input, and a 200kHz oscillator takes over timing under external battery power and lights a "mains failure" warning lamp.

MODEL AIRCRAFT RADAR

EMISSION of sulphur dioxide is a subject of current interest in Europe, since industrial emissions in one country have been found to affect air quality and the acidity of rainfall in neighbouring countries. Pollution from the U.K. has been said to harm the ecology of Scandinavian countries.

The latest sale of the Plessey WF3 Windfinding Radar to the Central Electricity Generating Board has extended its application to that of tracking model aircraft.

Following successful trials at the Plessey Cowes plant on the Isle of Wight, a WF3 MK2 version was purchased by the Central Electricity Research Laboratories (CERL) for tracking and measuring plumes of gases and particles emitted from power station stacks, using radio controlled model aircraft carrying various sensors. The radar system will be used in a mobile mode so that equipment can be located in the optimum position for returning accurate aircraft flight tracking data.

Research staff of the CEGB are seen at the I.O.W. during trials with their radio controlled aeroplane. The Plessey radar system is in the background

Market Place

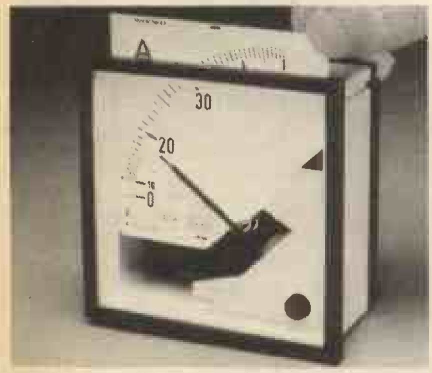
Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by Alan Turpin and David Shortland

INTERCHANGEABLE SCALE

A new range of IMO J Series analogue panel meters comprises ammeters, voltmeters (both moving coil and moving iron), varmeters and frequency meters. They feature interchangeable scale plates which are unplugged and reinserted without recourse to opening or tampering with the rest of the instrument.

They are available in three standard DIN sizes—72, 96 and 144mm square with quadratic scales for easy reading.



There is a wide range of scales from mA to MV. The meters have a full 90° sweep, compressed scales for overload, and employ silicon-damped, jewelled movements. The scales have "click" positive location for accurate reinsertion.

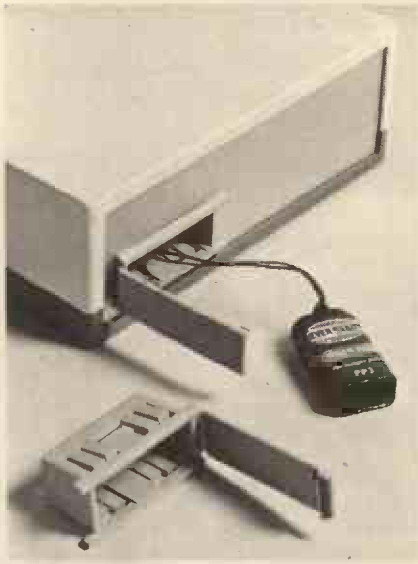
Transducers supplied with wattmeters or varmeters can be set for full or reduced power simply by switching an internal commutator, thus covering the majority of applications with a constant full scale output current of 5mA.

IMO Precision Controls, 439 Edgware Road, London W2 1BS. (01-723 2231/4)

EASY ACCESS BATTERY HOLDER

For projects needing a 9V battery this holder does away with having to take the project box apart when the battery gets flat.

A rectangular hole in a panel or enclosure with a thickness of 1·5 to 3mm is all that is required. The holder is simply pressed home.



Injection moulding has enabled the design to incorporate moulded retaining clips (holder to case and battery in holder) and also a flip-over hinged cover which snaps shut.

Complete with battery connector and lead for less than £1.

Battery Holder—Vero Electronics Ltd., Industrial Estate, Chandler's Ford, Eastleigh, Hants. SO5 3ZR. (042 15 69911).

ALTERNATIVE TO DAISIES

For frequent and fast setting these encoded numerical switches are worth consideration. They can be called up for decimal, hexadecimal, BCD, binary octal, and several other output codes, with options such as odd bit parity.

Each lever has a full travel of 90° and dial positions (8, 10 or 12) are selected by a positive click action. A bank of switches can be reset up or down with a single sweep of the hand. Number windows can be in the upper or lower part of the housing.

The housing is rear mounted into panels. A two bank switch is approximately 40mm wide and 30mm deep and takes about 40mm of space behind a panel.

Loading limits are 28V a.c. or d.c. at 50mA. Non-switching current is 1A. Life is over one million detent operations.

Full specification sheet, 1-0039, for series 28000 Minilever from sole suppliers (off the shelf), **Digitran UK, Melbourn, Royston, Herts SG8 6AQ (0763 61600).**

NEW TANDBERG CASSETTE DECK

The TCD 320 retains the three motor "Dual Capstan Closed Loop" tape transport system introduced by Tandberg. Seventy per cent of the cost of the machine is said to be devoted to the recording circuitry to ensure the most accurate recordings.

It can be operated in a variety of playing positions, mounted on a table-top, vertically or horizontally, or as a shelf model. It can be operated as either a front-loader or a top-loader.

Signal to noise ratio is 65dB minimum, according to DIN 45 500, while the frequency range is from 30 to 18,000Hz (DIN). The off-tape distortion is measured at 0·9 per cent.

A disengageable MPX filter cuts out the pilot signal when recording from FM stereo broadcasts, and the Dolby B noise reducing system cuts down tape-hiss by approximately 10dB at high frequencies.

MARSHALLS

The latest Marshalls catalogue which is now available features many new components and products including both the KIM and PET microcomputer systems which are available with a wide range of expansion units, peripherals and software.

The price of the catalogue is 50p post paid or 40p to callers. **A Marshall (London) Ltd., 42 Cricklewood Broadway NW2 3ET.**

ALPHANUMERIC PRINTER

The Printina CSC is a 24-column alphanumeric printer which can be adjusted by an internal trimmer to compress the characters until 32 columns can be printed on a single line.

Its fastest print rate is 1·2 lines/second with a 5·2V power supply (the unit will operate from 5V ±5 per cent). Write time is approximately 400ms and its working life is estimated at 10^6 lines without service.

The printer uses standard rolls of metallised electro-sensitive paper with a 25 metres roll allowing 5,000 lines to be printed. The paper roll is stored internally and a new roll can be fitted easily in a matters of seconds.

The price of the Printina CSC is £240 plus VAT.

For further information contact **Seltek Instruments Limited, Hoddesdon Road, Stanstead Abbotts, Herts SG12 8EJ.**

ENCAPSULATED CONVERTER

A new range of miniature encapsulated d.c./d.c. converter power supplies for providing stabilised 5V or 12V outputs from unstabilised 5V inputs is available from Gould Electronics. Both the MC (single-output) and MCD (dual-output) series have built-in metal casings for radio interference shielding, and are designed to be mounted on standard printed circuit boards.

Ten models are available in the range, with output current ratings of 1A or 2A for the 5V models, 400, 470, 800 or 940mA for the single-output 12V versions and ±190, ±230, ±412 or ±525mA for the dual-output 12V types.

Ripple is within 50mV peak-to-peak for single-output versions and 35mV peak-to-peak for dual-output versions and r.m.s. noise is within 1mV (20MHz bandwidth). The units measure 50 × 50 × 10mm for the 5W versions and 63·5 × 89 × 23mm for the 10W models.

For further information contact **Gould Electronic Components Division, Raynham Road, Bishop's Stortford, Hertfordshire CM23 5PF.**

ASCII KEYBOARD KIT

A 63 key ASCII standard keyboard capable of producing all upper and lower case alphanumeric symbols and control functions is now available from Newbear Computing Store. The keyboard requires only the addition of a 5V power supply, and the absence of MOS devices eliminates the need for either a negative power supply or any special handling precautions.

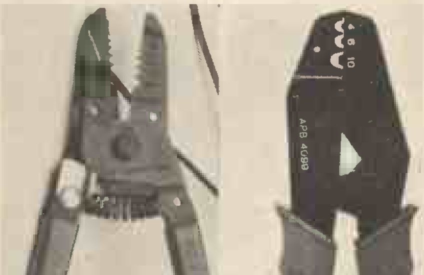
A simple optional switch allows the selection of upper case only or upper and lower case, and a red l.e.d. is provided as standard to indicate when the keyboard is in upper case mode.

All inputs and outputs are TTL compatible and follow normal 7400 series loading and level requirements. Positive logic is used, the eighth bit is an optional parity bit, and parallel output is standard. However, serial output can be provided by addition of a serial clock.

The price of the complete kit is £56 and full details are available from **Jon Day, Newbear Computing Store, 7 Bone Lane, Newbury, Berks RG14 5SH. Newbury (0635 49223).**

STRIPPERS . . .

The Milbar 15E which is covered by the Levermore "Belt and Braces" guarantee retails for a rec. price of £3·50 exc. VAT.



. . . AND CRIMPERS

AB Engineering have introduced a new range of light-weight crimping tools for 10-18 s.w.g. terminals.

BEEP! BEEP?

The new "Roadrunner" prototype wiring system is said to offer considerable economies on electronic and microprocessor development work and a fast, accurate means of producing pre-production circuit boards of any size, type or i.c. packing density.

Keys to the efficiency of the new system are the exclusive wiring instrument and the low-profile press-fix or glue-fix distribution strips employed. Together, they are said to allow fast, accurate working.

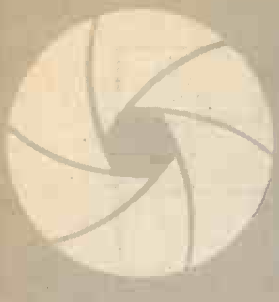
The wiring instrument, or "pencil", feeds the quick soldering enamelled wire from interchangeable bobbins. The instrument is balanced for easy handling and has a fine, long-life steel tip which aids accurate working, even in the most confined areas. Special features are the simple threading system which allows fast bobbin change and the facility provided for adjusting wire tension.

The castellated distribution strips have the capacity for retaining a large number of wires securely in position, without affecting the extremely low profile of finished boards. They have no posts to impede access when wiring.

"Roadrunner" systems are normally supplied in kits which include a circuit board, a wiring instrument, distribution strips and spare bobbins of wire in four different colours. However, individual components are available separately. A typical "Roadrunner" introductory kit retails at £8·50.

Agency enquiries are invited.

Further information from TJB Associates, Unit 116b, Blackdown Rural Industries, Haste Hill, Haslemere, Surrey, GU27 3AY.



DIGITAL ENLARGING EXPOSURE METER

A.A.LUHA B.Sc.

FOR THE PHOTOGRAPHER WHO DOES HIS OWN DEVELOPING

This device uses a photodiode to . . .

(a) indicate the required black and white developing time

(b) assess contrast on the negative, enabling suitable paper grade selection

For the amateur photographer who processes his own films and prints, the rapidly rising cost of photographic paper is a matter of serious concern, as is the pressure on one's time in our increasingly hectic life style. This article describes an exposure meter which enables the rapid and accurate assessment of printing times for black and white negatives and which will soon pay for itself in terms of saved time and bromide paper. The instrument was designed for the maximum possible convenience in use, together with a level of accuracy more than adequate for all black and white printing.

The meter consists of a light sensor, which is a small area high speed photodiode, an adjuster for paper speed, which may be a potentiometer or switch, a digital display, and an on/off switch. In use, the light sensor is used to find the area of maximum brightness on the enlarger baseboard, which of course corresponds to the darkest part of the print itself. This area gives a reading on the display, of the exposure time required for the print, directly in seconds. The meter itself is linear from one to more than five hundred seconds, which is way beyond the linearity of any photographic emulsion due to reciprocity failure. The inclusion of the third digit in the display, however, enables a second valuable measurement to be made very rapidly indeed, and that is the direct assessment of contrast range of the negative and hence the correct choice of paper grade for the enlargement.

Before describing the circuit and its method of operation, it will be useful to review what we require the instrument to do in a photo-physical sense. The exposure time required for a piece of bromide paper depends only on the intensity and wavelength of light falling on it. The distribution of wavelengths is dependent on the light source and, for the usual tungsten enlarger lamp, is both biased towards the red end of the spectrum and strongly dependent on filament temperature. The latter varies significantly with applied voltage and can be a considerable problem in colour printing. Fortunately, as far as black and white printing is concerned, mains voltage variation does not cause a real problem, even with completely unstabilised lamp supplies. Thus, as far as assessing exposure times is concerned, the only variable of interest is light intensity at the enlarger baseboard, and the fundamental relationship is that exposure time is inversely proportional to light intensity. In mathematical terms we can write:

$$\text{(a)} \quad t = \frac{K}{L}$$

Where t is exposure time, L is light intensity, and K is a constant which takes account of the paper sensitivity and the spectral distribution of light from the enlarger lamp. We see then that an enlarger photometer is required to accept light intensity as an input variable, and output exposure time as the indicated parameter.

CIRCUIT DESCRIPTION

The basic operation of the instrument can most easily be understood by reference to the block diagram, Fig. 1(a). The light intensity at the enlarger baseboard is converted to a proportional photo-current by a reverse biased high speed silicon photodiode. This device offers a high degree of linearity of current with light intensity. The minute photo-current is converted to a proportional voltage by an op-amp connected as a current to voltage converter. The output of this stage is fed into an active low pass filter to remove the considerable 100Hz signal (due to alternate heating and cooling of the lamp filament twice during each mains cycle). The d.c. signal at the output of the low pass filter is passed to a voltage to frequency converter whose output frequency is proportional to the light intensity.

It is required to derive a signal which is inversely proportional to light intensity, and this is the *period* of the voltage to frequency output oscillation. This stage is therefore used to gate the output of a master clock generator (running at constant frequency) into the input of a digital counter/display module. Thus, as light intensity increases the time for which the gate is open is decreased, and the resulting number of clock pulses getting through to the counter is proportional to the exposure time required. Variable control of the master clock frequency establishes the constant of proportionality in equation (a), and this is brought out to the front panel of the instrument as the paper speed setting. Apart from the on/off switch, this is the only control requiring adjustment after initial setting up.

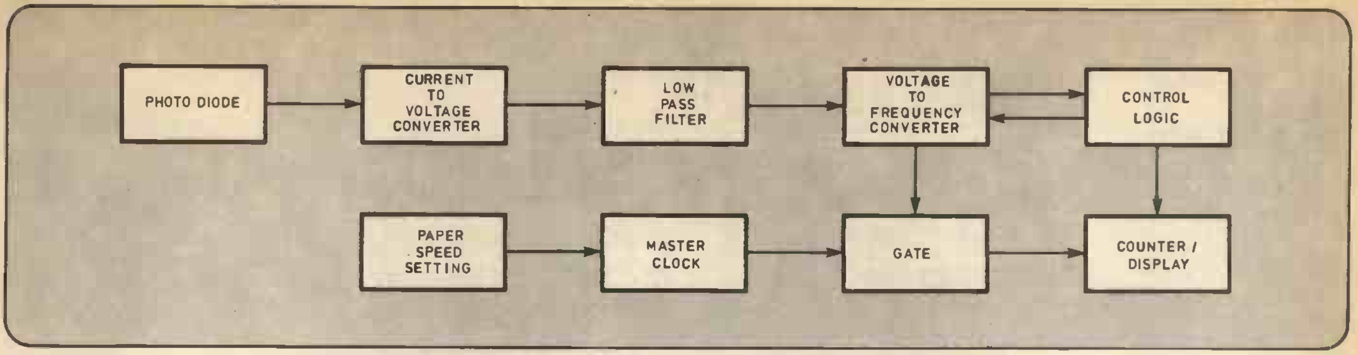


Fig. 1(a). Block diagram of Exposure Meter

Detailed operation of the circuit, shown by Fig 2, is best understood with reference to the timing diagrams of Fig. 3. IC1 is connected as an inverting amplifier and acts as a current to voltage converter in this application because the effective source resistance of the photodiode is many orders of magnitude greater than the input resistor R1. This resistor, which could be left out completely, serves to limit the input currents to IC1 in case of catastrophic failure of the photodiode. IC1 is one of the recently introduced BIMOS operational amplifiers and is used here because of the need for extremely low input bias current.

FILTER

The negative going signal at the output of IC1 consists of a d.c. level and a superimposed 100Hz sinewave. Although both the a.c. and d.c. components are proportional to light intensity, the d.c. signal is substantially larger than the a.c., and therefore using this reduces errors. The a.c. component is filtered out by the two-pole active filter formed by IC2, and R3, R4, R5, R6, C2 and C3. The CA3140 op-amp is used again in this stage because the very low input bias current permits the use of high value input resistors and hence relatively small capacitors, without the disadvantage of a large d.c. offset.

The negative d.c. level at the output of IC2 is applied to the inverting integrator IC3, R7, C4. Discharge of the integrator capacitor is accomplished by the transmission gate IC5(b), while IC5(a) shorts the input of IC3 to ground. The CA3140 is extremely valuable in this integrator because it permits a small integrator capacitor and large integrator resistor, which allows simple resetting of the integrator..

The output waveform of the integrator is shown in Fig. 3(a). It consists of a positive going linear ramp and an exponential discharge. The integrator output is applied to a fourth CA3140 operating open loop as a comparator. The reference voltage for the comparator is obtained from a simple Zener stabiliser, but the exact arrangement of earth return and positive supply is of crucial importance, and will be referred to in the constructional information. The use of the CA3140 in the comparator position is mainly due to its rapid slew rate, being approximately an order of magnitude faster than the standard 741.

The output of the comparator is a series of positive going pulses shown in Fig. 3(b). The pulses are applied to the input of the monostable multivibrator IC6(b) and IC6(c), via the NAND gate IC6(a). The NAND gate IC6(a) serves two purposes. Firstly it inverts and sharpens up the comparator pulses to the correct waveform for firing the monostable, and secondly it provides the vital power up reset pulse from R10, C5. The output of the monostable is inverted by IC6(d) thus giving two complementary pulses in response to the comparator pulse.

The positive going pulse at the output of IC6(d) is applied directly to the control inputs of IC5(a) and (b) where the high logic level opens the transmission gates and thus resets the integrator. The output of IC6(d) is further applied to the input of IC7(a) which is half of a CD4098 dual monostable multivibrator. The monostable is triggered by the rising edge of the reset pulse and complementary outputs are available at its Q and $\overline{Q}$ output pins. The positive going pulse at pin 7 ($\overline{Q}$) is used to trigger the other monostable IC7(b) and also directly as the "transfer" pulse for the count display i.c. The output from IC7(b) is this time taken from the Q output since the counter display requires a negative going pulse to clear it.

The negative going pulse at the output of IC6(c) is used to inhibit the counter by closing the transmission gate IC5(c) during the reset period. The sequence of operation can be readily understood with the help of Fig. 3. Whilst the integrator is running up, clock pulses from the NE555V master clock generator are allowed through the transmission gate IC5(c) to the count input of the ZN1040E. When the comparator fires at the end of the integration period the count is disabled by the negative going pulse from IC6(c). One propagation delay later the main reset pulse at IC6(d) resets the integrator. During the reset period the transfer and clear pulses are generated sequentially. The transfer pulse causes the total count during the integration period to be latched by the display, and the clear pulse resets the counter to zero. It is important therefore that both transfer and reset are over before the next count is enabled. Fortunately the ZN1040E can respond to very short duration pulses which can easily be made to fit within the reset period without the need for precision components in the dual monostable circuit. The length of the reset period is not critical in any case, since the master clock is gated into the counter input.

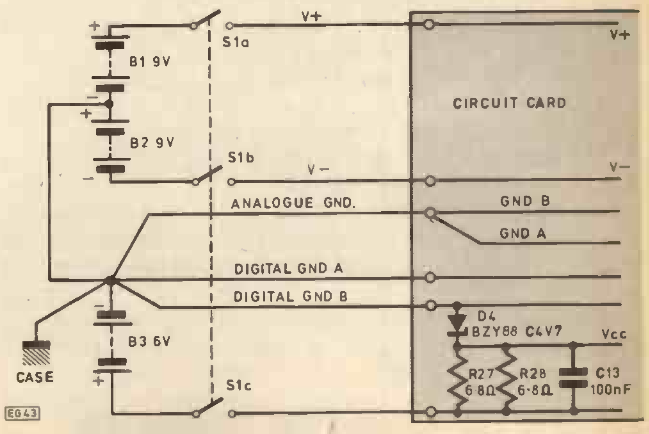


Fig. 1(b). Power supply arrangement

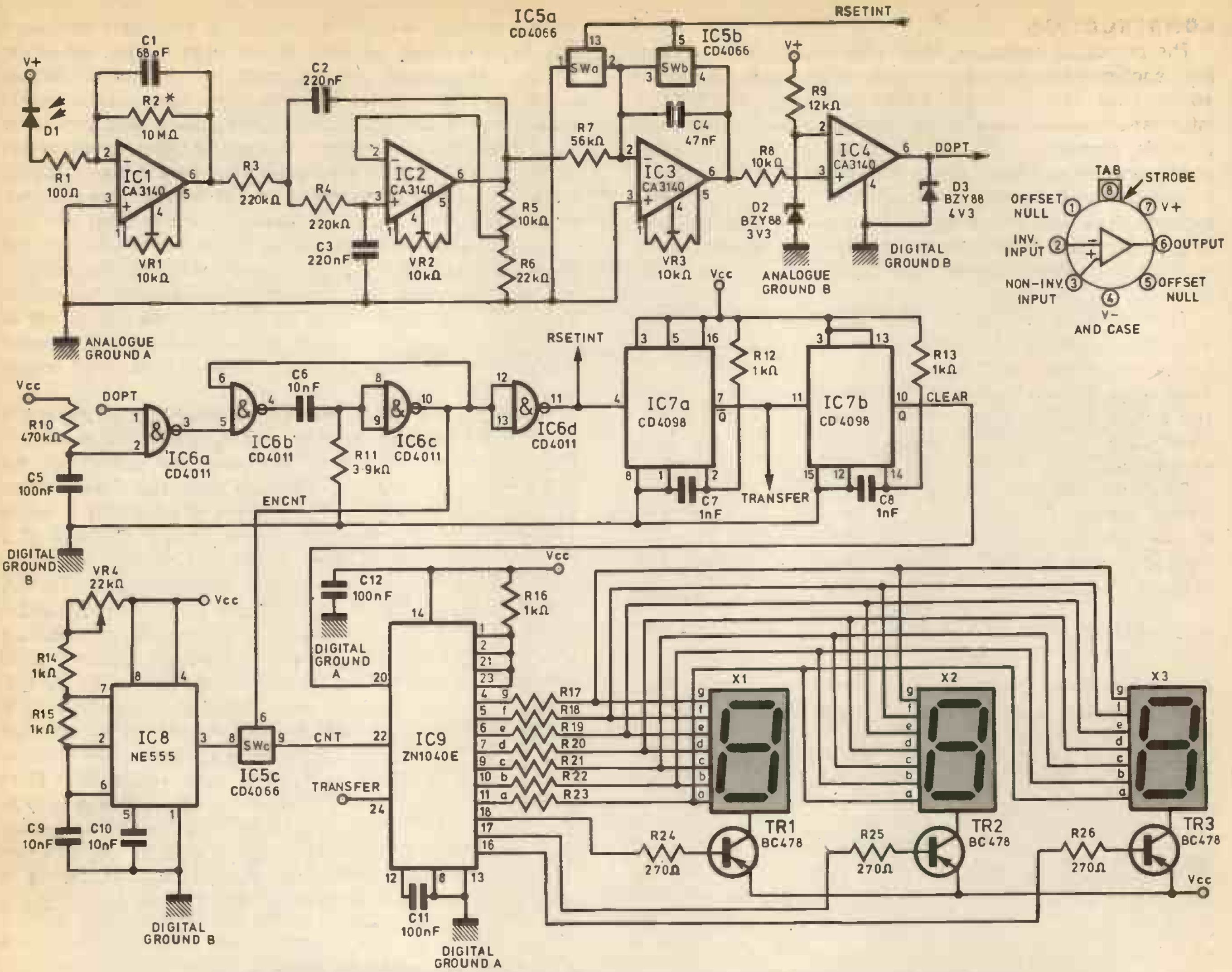
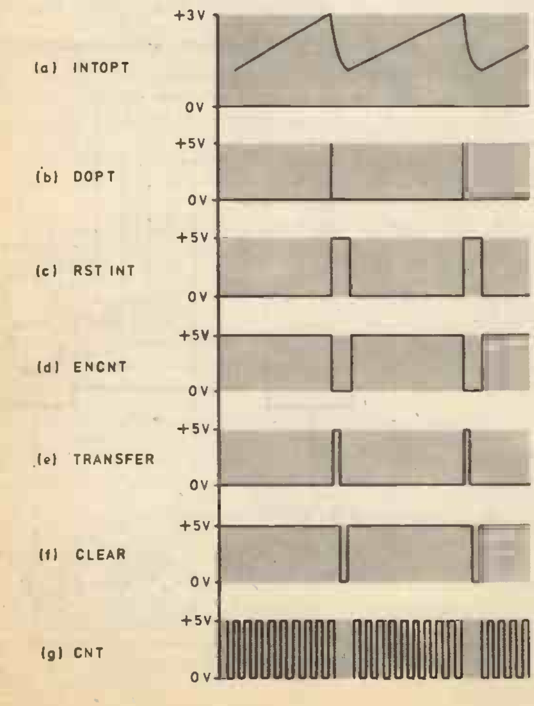


Fig. 2. Circuit diagram. IC1–3 powered by + and −9V, IC4 by +9V and DIGITAL GND B

Fig. 3. Correct waveforms for the various signals generated



POWER-UP RESET

The only remaining parts of the circuit calling for some comment are the requirement for the power-up reset pulse and the use of the ZN1040E counter display i.c. The power-up reset pulse is essential because the integrator reset pulse is generated from a monostable. Thus, at start up, when power is first applied, if the comparator went to its high state before the reset monostable was enabled there would be no means of resetting the integrator. The simple RC network R10, C5 supplies a once only reset pulse approximately 50ms after switch-on, thus ensuring the integrator is reset.

The ZN1040E is a recent addition to the designer's armoury and a most valuable one. Its single package counts, latches, display-decodes and drives 7 segment displays together with full leading zero suppression and many other valuable features. The chip is capable of driving common anode or common cathode displays, and the circuit of Fig. 2 is shown wired for a common anode display. This configuration uses fewer resistors and transistors for interfacing, but the internal multiplex clock must be slowed down by external capacitor C11 in order to eliminate ghosting in the display segments (caused by the finite turn off time of the p.n.p. anode access transistors). Constructors wishing to use common cathode displays should refer to Fig. 4 which gives the necessary connection information. The use of the three most significant digits of the four digit counter is a simple but effective way of reducing jitter in the final display.

CONSTRUCTION

The prototype exposure meter was conceived as a hand held spot-measurement instrument which could be moved about over the enlarger baseboard, and display its information continuously at the baseboard itself, rather than a static metering unit with a probe at the end of a connecting cable. Thus there is the necessity that the meter should be both battery powered and small. The author experimented with the recently introduced "Verowire" wire wrapping system in an attempt to obtain the advantages of double-sided wiring, rather than designing a double-sided p.c.b.

The Verowire system proved a reasonable solution although a number of disadvantages became apparent. In particular, debugging the complete circuit proved to be much more difficult than with a conventional wiring method. The author would suggest that the use of standard 0·1in. Veroboard would be a wiser solution for the less experienced.

From the point of view of electronic construction and wiring, perhaps the most important single point is the need to use separate earth returns and positive supply lines for various parts of the circuit. This practice is an essential part of many professional instrument designs.

DECOUPLING

In a hybrid analogue and digital circuit, two major practical problems concerned with power supplies and their interactions are apparent. Digital integrated circuits change state so rapidly that the rising and falling edges of the transitions generate considerable switching spikes. In an undecoupled circuit the transients can cause sufficient amplitude supply line interference to cause unwanted or false switching of other circuits, but simple capacitative decoupling by the use of 10 to 100nF ceramic or polyester capacitors disposes of this problem. This measure may be insufficient, however, to eliminate problems in an analogue circuit using the same power supply, because by definition an analogue signal processing circuit should be capable of handling all signal levels with minimum distortion.

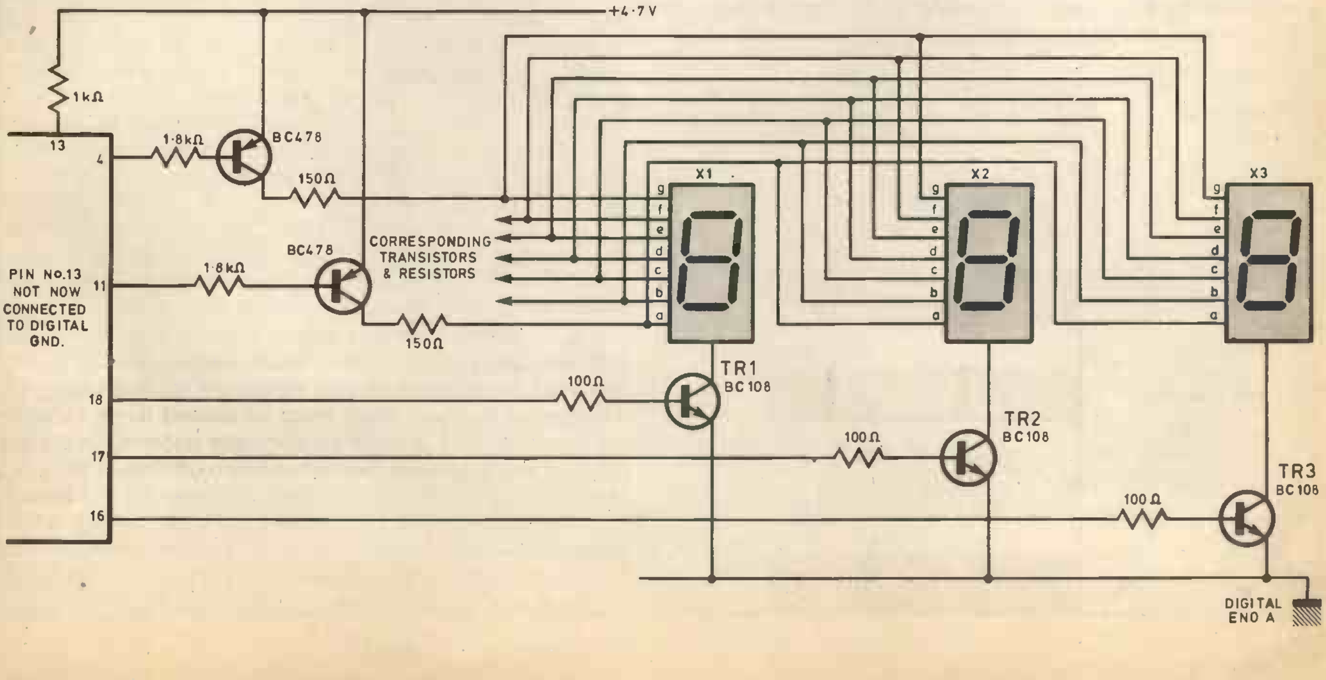
A second difficulty arises if the analogue circuit is used to process signals down to d.c., because now the possibility exists of the digital circuitry introducing d.c. offsets caused by the voltage drop of current flowing through the copper interconnecting wire. This problem is especially serious if TTL logic is used because of the high current switching "gulps" associated with it, and for the same reason, whenever l.e.d. displays are used. These two reasons dictate that separate analogue and digital power rails should be used. There still remains the problem of referring one power supply to another. The simple guideline here is that no *digital current* should be permitted to flow in the analogue circuitry, and this is most simply achieved by connecting the two power supplies together at a single point and running separate analogue and digital ground wires to this point. In the present design two separate digital ground wires were used. One was used for the ZN104E and the second for all other logic circuitry. This is because by far the greatest current drain is taken by this i.c. and l.e.d. displays whose current flows through it.

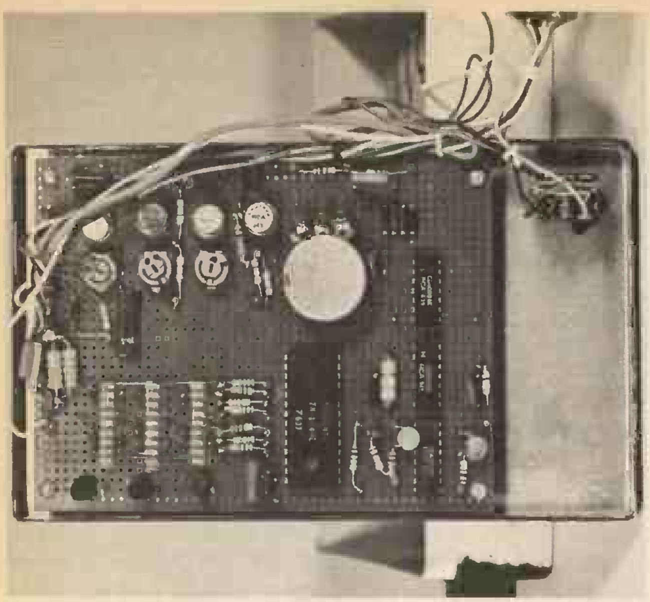
In the present design the most critical part of the entire circuit is the comparator of the analogue to digital converter, because it is required to compare the output of the integrator with a stable reference potential. The method adopted here illustrates the problem of obtaining a stable potential from the analogue power supply. The use of a battery supply means that a simple potential divider is unsatisfactory because the internal resistance of the battery causes potential shifts on the supply rail as the current demand of the circuit alters. A simple Zener stabiliser removes both of these problems providing a stable ground reference potential is available. Here the only problem is in the voltage drop caused by the *analogue current* flowing in the copper conductor wire or strip of the analogue circuit return line. This too will be changing at each instant of time. The solution is to run a separate earth return wire from the ground end of the Zener diode (anode in this circuit) to the battery connection at the board. With these precautions the simple Zener stabiliser has adequate performance without the need for temperature compensation or a constant current source. Refer to Fig. 1(b) for details of the power line arrangement.

DEBUGGING AND SETTING UP

An oscilloscope is most useful but is not essential. Start by making the display circuitry operate in conjunction with the master clock. It will be helpful to slow down the clock

Fig. 4. Alternative wiring for common cathode displays





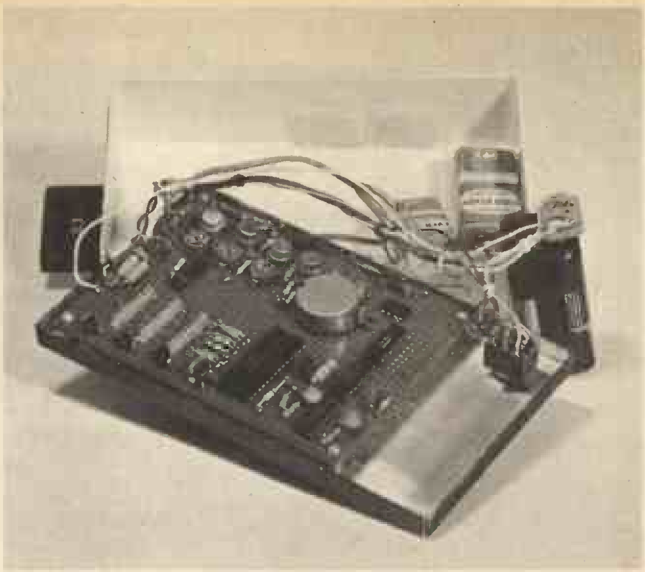


Table 1. CONTROL FUNCTIONS OF THE ZN 1040E

FUNCTION	PIN NO	LOGIC LEVEL TO OPERATE	EFFECT
Lamp Test	2	0	Displays 888
Digit Select Sense	13	0	For common anode displays.
		1	For common cathode displays.
Clear	20	0	Clears counter
Up/down Select	21	1	Count up
Count Input	22	0→1	Increments counter
Count Inhibit	23	0	Inhibits counter
Transfer	24	0	Latches display.
		1	Transfers current contents of counter

COMPONENTS LIST . . .

Resistors

R1	100Ω
R2	10MΩ*
R3, R4	220kΩ (2 off)
R5, R8	10kΩ (2 off)
R6	22kΩ
R7	56kΩ
R9	12kΩ
R10	470kΩ
R11	3·9kΩ
R12–R16	1K (5 off)
R17–R23	470Ω or 150Ω* (7 off)
R24–R26	270Ω (3 off)
R27, R28	6·8Ω (2 off)

*R17–R23 select 150Ω–470Ω depending on display colour/brightness desired. *R2 see text.

Potentiometers

VR1–VR3	10kΩ Skeleton preset (3 off)
VR4	22kΩ Carbon linear

Capacitors

C1	68pF Silver mica or polystyrene
C2, C3	220nF Ceramic (2 off)
C4	47nF Ceramic
C5, C12	100nF Ceramic (2 off)
C6, C10	10nF Ceramic (2 off)
C7, C8	1nF Ceramic (2 off)
C9	10nF Polystyrene
C11, C13	100nF Polystyrene (2 off)

Transistors and Diodes

TR1-TR3	BC478 (3 off)

Displays

X1–X3	Any common anode 7 segment led display

Integrated Circuits

IC1–IC4	CA3140 (4 off)
IC5	CD4066
IC6	CD4011
IC7	CD4098 or MC14528
IC8	NE555
IC9	ZN1040E

Semiconductors

D1	BPW34
D2	BZY88 3V3
D3	BZY88 4V3
D4	BZY88 4V7

Miscellaneous

S1 3 pole toggle switch
Battery connectors

generator to about 20 or 100Hz (by wiring a large capacitor across C9) and applying it directly to the count input of the ZN1040E. Refer to Table 1 to ensure that the count display operates correctly in response to the transfer and clear functions. Remember to establish a logic 1 condition by using a 1kΩ resistor between Vcc and the i.c. input. Remember also that the counter will divide the master clock frequency by 10 because only the three most significant digits are used. Next, ensure that the chain of inverters and monostables operates in the correct sequence. If an input pulse generator is available, together with an oscilloscope, things are easy, but the simple trick of slowing pulses down by wiring large value capacitors temporarily in parallel with the normal circuit values makes it possible to trace through the circuit with nothing more than a multimeter. Establish that a positive going pulse at pin 1 of IC6(a) fires the monostable IC6(b), (c) and that complementary outputs are available at pins 10 and 11 of this i.c. Check that the positive going pulse at pin 11 of IC6(d) is responsible for initiating the output of IC7(a) and that the negative going edge of IC7(a) output fires IC7(b). In normal operations it is essential that the transfer and clear pulses occur within the reset width. This is impossible to verify without an oscilloscope, but the circuit constants given allow a substantial margin for component tolerances.

Next establish that the analogue to digital converter is operating. Again it is possible to slow things down to multimeter speeds by temporarily increasing the value of the integrator capacitor C4. Short the input end of R7 to analogue ground and apply a signal to IC3 via a resistor of between 1MΩ and 10MΩ temporarily connected to pin 2 of IC3. Disconnect the output of IC4 from the input to IC6(a). Confirm that the integrator will ramp positively for a negative input signal and negatively for a positive input. With a negative input signal and positive ramp, check that the comparator output at IC4 pin 6 changes state at about 3·3 volts. If all seems well, reconnect IC4 to IC6(a) when the comparator transition should initiate resetting of the integrator. The output spike of the comparator will be too fast to observe with a multimeter but it is possible to ascertain that the integrator resets and ramps at pin 6 of IC3. When all is well remove the temporary input resistor and large value integrator capacitor. With the input end of R7 still grounded, adjust the d.c. offset potentiometer associated with IC3 for the minimum rate of positive going ramp. It should be possible to obtain a period of about 10 seconds between resetting of the integrator. Finally, remove the short from the output of IC2.

The next stage to set up is the active low pass filter IC2. It is not so easy to establish this stage is operating correctly without an oscilloscope. The stage acts as a non-inverting d.c. amplifier with a gain of about 1·5, for voltage inputs applied directly to pin 3. If this can be established it is probably safe to assume no wiring errors exist and that the circuit is also operating as a filter. The offset potentiometer is adjusted by grounding the input at pin 3 and adjusting for the minimum rate of positive going ramp at the output of IC3. If an oscilloscope is available the filter action is best established in conjunction with IC1.

IC1 operates as a straightforward current to voltage converter. The output of IC1 will contain a significant a.c. component of 100Hz if the photodiode has light from a normal household tungsten bulb incident on it. This should be absent at the output of IC2 if the latter stage is operating correctly. The d.c. offset adjustment of IC1 should be set up in an analogous manner to IC2 and IC3 (i.e. by adjusting for minimum rate of ramp at IC3 output). For this stage it is important to compensate for the dark current of the photodiode which must therefore be in circuit, but in total darkness. This offset adjustment constitutes the final electronic setting up with the possible exception of some adjustment to R2 depending on the light source used in the enlarger.

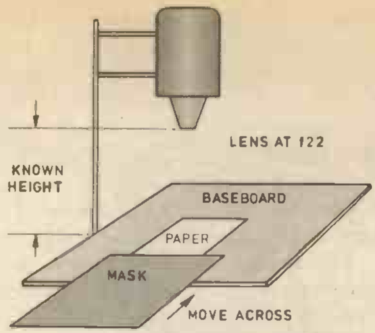


Fig. 5. Making a test strip

Fig. 6. Test strip

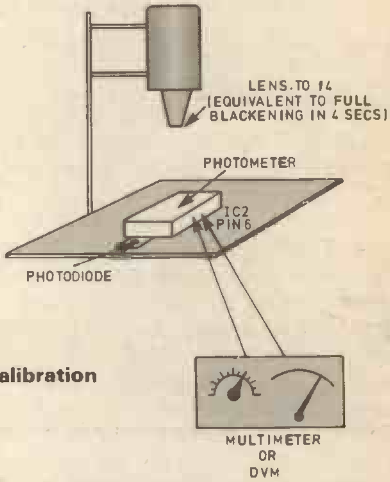


Fig. 7. Calibration

CALIBRATION AND PHOTOGRAPHIC USE

The method of calibration of the photometer is to adjust the display readout to give the exposure required to obtain a black level on the final print. Electronically this is accomplished by adjusting the clock frequency using the paper speed control, VR4, after ensuring that the photometer is operating in a linear region of its first stage amplifier for normal working light levels. It is necessary that the calibration is carried out in conjunction with a carefully prepared photographic test strip. The photometer is sufficiently accurate and reproducible to make it feasible, and worthwhile for the advanced worker, to make separate test strips for each make, grade, and surface of paper normally used.

Start the calibration by making a test strip with the enlarger at an extension of about 800mm from the baseboard, with the lens fully stopped down, and with nothing in the negative carrier. Make a note of the settings so that they can be exactly reproduced at a later date. This will help if any modifications to the enlarger optical system or radical changes in photographic methodology are contemplated later on. Start using grade 2 (normal) paper.

Place a sheet or strip of paper on the baseboard and have ready a piece of cardboard sufficiently large to cover the entire piece of photographic paper. Switch on the enlarger and begin exposing the paper. Cover up strips of the paper at the following times (seconds): 2, 3, 4, 5, 6, 8, 10, 13, 16, 20, 25, 32, 40, 51, 64, 81, 102, 128, 161, 203, 256. This sequence gives increases in exposure approximately equivalent to one third of a stop. See Fig. 5.

Alternatively the sequence: 2, 3, 4, 6, 8, 11, 16, 23, 32, 45, 64, 91, 128, 181, 256, which gives increases equivalent to half a stop may be used. Switch off the enlarger and develop the test strips in the manner which will be used for developing actual prints. Pay particular attention to developing for a fixed time at a fixed, *certainly known*, temperature, and for these test strips, which will be reference items in the future, use freshly prepared developer.

FINISHED TEST STRIP

The resulting print should contain strips of grey each distinguishable from the other with one or more strips corresponding to pure white (i.e. indistinguishable from each other and from the paper base), and one or more strips corresponding to pure black and again indistinguishable from one another. If this result is not obtained, repeat the test strip until it is, by increasing or decreasing the light level at the base board. Thus, even if with a two second exposure some darkening of the paper is discernable, decrease the light level by increasing the extension of the enlarger or by inserting a neutral density filter in the light path. A piece of wiremesh such as a tea or coffee strainer would be ideal for this. Alternatively, if a difference between the two longest exposures is seen, increase the light level at the baseboard by opening the enlarger lens one or two stops. In any event aim for a test strip which encompasses full white and full black. Note that even for grade 1 glossy paper the range of densities which can be seen is unlikely to be more than 40:1. For non-glossy and harder papers this contrast range will be significantly less, reducing to about 5:1 for grade 5 paper. Mark on each distinguishable strip of density the actual exposure time as this will be valuable later on for more advanced work.

Consider the test strip made on grade 2 (normal) glossy paper (see Fig. 6). In the examples shown the first discernable strip occurs at 6 seconds whilst no further increase in blackening occurs after 128 seconds. This effect has taken place at a known enlarger extension (normally 800mm) and at a known aperture (say f22), which together define the intensity of light falling on the baseboard. We now require to adjust the photometer so that it indicates the correct exposure time in seconds to get a black level on the final print, and most importantly to ensure that it is working within its linear region of operation.

Switch on the photometer and place it on the enlarger baseboard. Monitor the output of the low pass filter at IC2 pin 6 with a multimeter or DVM if available. The aim is to adjust the resistor R2 so that with the maximum light which will fall on the photodiode sensor in practice, the output of IC2 is well below saturation, i.e. about 4 volts. A suitable light level to aim for is that which would give complete blackening of the paper in about 1 second. This light level is unlikely to be exceeded under normal working conditions because of the difficulty of timing the exposure manually or of obtaining reproducible results from an electronic timer due to thermal lag of the filament at such short exposures.

BLACK TIME

In the example of Fig. 6 complete blackening has occurred at 128 seconds. In order to increase the light level so that complete blackening would occur at 1 second, an increase of light of seven stops is needed. Thus, if the test strip was made at f22 we need to open the enlarging lens to f2. On many enlarging lenses this is not possible because the maximum aperture may be only f4. If this is the case either change the enlarger-to-baseboard distance to 400mm which will give four times (2 stops) more light intensity at the baseboard, or more simply set up the photometer so that the output at pin 6 of IC2 will be about 1 volt (i.e. about $\frac{1}{4}$ of 4V). It should be found that the starting value of R2 given, 10MΩ, is not too far out. See Fig. 7.

It is absolutely essential that during the selection of R2 only light from the enlarging lamp reaches the photodiode.

A normal darkroom safelight is completely useless for this procedure because the photodiode specified has extended red sensitivity and light from even a tiny safelight yards away will be many times more than that coming from the enlarger. If a DVM with l.e.d. display is used there will be no difficulty, but if an analogue multimeter is used it means that the scale must be read either by the light of the enlarger itself or by a small torch which must be well screened from the photodiode. Select R2 so that when the light intensity would cause full blackening in 1 second, the output of IC2 pin 6 is about 4 volts. This adjustment is in no way critical, but is important to ensure that the amplifier is not saturating. A value for R2 giving 50 per cent less output than suggested will give perfectly good results.

When the value of R2 has been established the photometer has been calibrated photometrically. The value on the digital display should now be in the range of the paper speed control. Return the enlarger to 800mm extension and minimum aperture, and check that with all other lights extinguished the photometer can be adjusted to read 128 seconds. This reading is of course that value of exposure which will give a black level on the final print. Check the linearity of the photometer by opening up the enlarging lens. The indicated exposure should halve for each stop increase. Do not be too worried if there is not an exact twofold change in reading because the photometer is likely to be more accurate than the mechanical stop of the lens.

SIMPLE TO USE

Having calibrated the photometer, using it is simplicity itself. Put a negative in the carrier and using the photometer, select the area of maximum brightness. The indicated reading will be the exposure required to give a true black level for that area of the negative. This criterion is usually met in practice, but false readings will occur if no black level is present on the negative. An alternative means of using the photometer is to set the paper speed control so that the photometer indicates a correct flesh tone. To do this refer to the calibration test strip for the correct exposure needed to give the required flesh tone and set up the enlarger to the standard conditions used for making the test strip. Adjust the paper speed control to give the required number and the photometer is now calibrated in terms of standard flesh tone.

PAPER GRADE

As stated at the beginning of the article the photometer can be used to assess the correct grade of paper needed for an enlargement. A brief indication only of this use will be given since the interested photographer will find the necessary information for himself. Suppose a negative has areas corresponding to pure black and pure white. When this is projected in the enlarger the photometer can be used (without alteration of the paper speed control) to compare directly the intensities corresponding to pure black and pure white. For example, suppose the brightest part indicates an exposure time (for maximum blackness) of 10 seconds, and without altering the setting, the darkest part indicates an exposure time of 80 seconds, then the contrast range is 8:1. This contrast range of the negative must be fitted onto a printing paper with the same contrast range in order for a full black and a pure white to be apparent. In our example of Fig. 6 the paper had a contrast range of 128 : 6 = 21:1. Thus it would be unsuitable for a negative whose range was only 8:1, because an exposure necessary to cause full blackening of the paper would cause the whites to come up very grey. It should now be apparent how the combination of test strips and photometer can be used to select both the correct exposure and the correct paper grade in conjunction. ★

News Briefs

MORE BUBBLES!

NATURE is full of bubbles! Just when magnetic bubbles are beginning to make their mark on memory technology, another type of bubble is discovered, *made of light*.

Last year, scientists at IBM's San Jose Research Laboratory discovered that microscopically small sources of light in a particular class of electroluminescent thin films can become mobile under certain conditions.

When a voltage oscillating at a high enough frequency is applied across one of these thin films, tiny light-emitting filaments, each about one micron (1/25,000 inch) in diameter, appear to pour out from isolated points in the material and to swarm randomly about in it.

Discovery of the mobile filaments occurred during experiments aimed at understanding the light-emitting properties of manganese-doped zinc sulphide films. Non-mobile light properties of these films are being investigated by a number of laboratories that are interested in information display technology.

Images can be formed in devices based on this material either by stimulating areas of the film with a light beam or an electron beam, or by applying an "addressing" voltage across the film to induce light emission from selected areas of the material. An important feature of these so-called ACTEL (alternating current thin-film electroluminescence) devices is a "storage" effect that enables them to retain an image for an extended length of time without the necessity of periodically refreshing the screen, as is needed in cathode-ray-tube storage displays.

In the IBM experiments, an AC voltage is applied to the film via sets of crossed metallic lines about one millimeter wide, the horizontal lines being deposited on one surface of the material and the vertical lines on the opposite. When voltage is applied to a pair of intersecting electrodes, the intersected area of film will emit light. Each such area encompasses some tens of thousands of individual light-emitting filaments. It is these individual filaments that can become mobile.

As the frequency of the applied voltage reaches the neighbourhood of 10,000 hertz, the threshold of filament mobility is achieved. Looking at the light-emitting filaments through a microscope, one can see the tiny spots of light moving in small, discrete steps from one location in the material to another. On close examination, it appears that the illumination is being transferred from one site to another through a process in which the emission from a filament is extinguished at approximately the same time as emission from another begins.

Raising the frequency of the applied voltage still further (to about 50,000Hz) causes the mobility of the light bubbles to increase as they wander over relatively broad areas of the film. When one bubble approaches another, they repel each other. Isolated regions in which the mobile bubbles are generated can be clearly seen in microscopic views of the material, and at high frequencies, hundreds of the moving points of light appear to *pour* out of these sources like water from a bubbling spring.

The locations of the sources of mobile filaments are thought by the researchers to be associated with microscopic defects in the polycrystalline structure of the zinc sulphide films.

FIVE-STEP A TO D

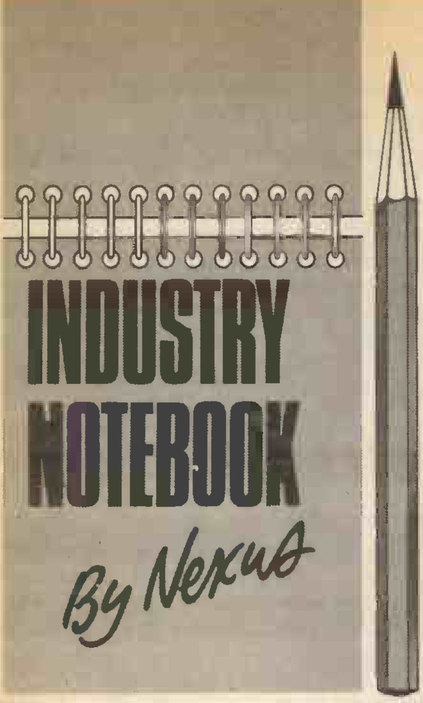
A NEW five-step analogue level detector with a high impedance input has been announced by Texas Instruments. The TL489 consists of five comparators to digitise analogue input signals.

The five comparators and a reference voltage source detect the level of an input signal. Output 1 is switched to a low logic level at a typical input voltage of 200 millivolts. After each additional 200-millivolt step, the subsequent outputs are switched to low logic levels. All outputs are switched to low logic levels at a typical input voltage of 1000 millivolts (full scale). The open-collector outputs are capable of sinking currents up to 80 milliamperes and may be operated at voltages up to 18 volts. The analogue input has a high impedance of 100 kilohms.

Since all five trigger points have a switching hysteresis of typically 10 millivolts, the circuit may be operated with slow input signals without danger of oscillation at the outputs. To prevent pick-up of noise, a capacitor should be connected between the high-impedance input and ground, especially when the input is driven from a high-impedance source.

The TL489 is especially designed to detect and indicate analogue signal levels. The device may be used in various industrial, consumer, and automotive applications. Power outputs are suitable for driving a variety of display elements such as LEDs or filament lamps. The output may also drive digital integrated logic such as TTL, CMOS, or other high-level logic.

The TL489 in an 8 pin plastic DIP is characterized for operation from 0°C to 70°C. Price in 100-piece quantities is £0·45. The new analogue level detector is available from TI authorised distributors and from TI Bedford.



VLSI Chat

The VLSI publicity bandwagon rolls on. Inevitably the word "chip" is the one that has caught on, sometimes qualified by "silicon". Few people in the UK can have missed hearing about it. Just as people now identify the "pill" with birth control, so the "chip" according to popular viewpoint means disaster (six million unemployed) or the dawn of an earthly paradise (unlimited wealth and leisure).

Lay people are now convinced that whatever the chip might be—few actually understand what it is or what it is supposed to be able to do—the one sure thing is that we must have it. Why else would the Government be backing it with first £50 million, then £100 million, now £200 million, tomorrow £500 million? Could it be for votes?

Inmos

Inmos, meanwhile, struggles manfully on, surrounded by unseemly squabbles on siting of technical centres and plants. Which development areas will get the plants, each with a thousand workers? Will prosperous Bristol have the technical centre? What's wrong with Newcastle? The debate rumbles on with the odd touch of hysteria, sudden swoops into farce, occasional excursions into fantasy.

Endless speeches and lobbying, even allocation of vast sums of money, are no substitute for policy. Yet to be decided are product lines and how they will be marketed. On these important topics both the National Enterprise Board and Inmos are strangely silent. There could be good reasons for remaining dumb. Commercial security, for example. Industry experts, however, remain sceptical that any organisation largely influenced by political considerations can be commercially successful.

The Real World

Let us now turn away from speculation and look at the real world and what real people are doing in it.

First, Racal Electronics Group who celebrated another successful half-year report (profits up 25 per cent on 11 per cent increase in turnover) with the announcement of a £20 million export order, the largest ever received in the Group's 28-year history. It is for a communications package for an unspecified country in the Middle East and takes in products from a number of Racal companies.

I have often referred to Racal as "unstoppable". They continue so with unparalleled vigour and determination to do even better. Racal exports average out at £16,000 in value per worker, a figure unmatched in the UK by any other manufacturing company. It does your heart good to talk to the directors, enthusiasts all, never harking back to the "good old days", instead looking forward to every new challenge ahead.

One such challenge is electronic warfare. Expect to hear later this year about Jaguar. Not an automobile but Racal's answer to battlefield jamming. In Racal's book Jaguar is the acronym for JAmming GUArded Radio on which one of Racal's top design teams has been engaged for the past two years. It is a frequency-hopping field radio which, because it is continuously changing its frequency, is difficult to intercept, or jam or get a bearing on.

Expect, too, to hear of more Racal acquisitions both at home and overseas. Parts of Decca and Plessey are still tipped as possibles, indeed probable, acquisitions for Racal in any industry rationalisation programme.

Meantime data communications is one of Racal's big growth areas in cash terms with a projected £75 million turnover this year. The business is world-wide and still expanding fast. Racal's main manufacturing bases and biggest single market are in the USA where the Racal pay-roll has now soared to 2,300 people.

Expansive Giant

The other front-runner is giant GEC, also busy expanding in the UK and overseas. The recent acquisition of the US company A. B. Dick has opened the door for GEC's entry into the profitable office equipment market, the negotiations with Avery provide an electronic weighing market if the deal goes through, and the joint venture with Fairchild will bring GEC into the major league in VLSI with both technology and marketing outlets.

The logic of all this activity is that apart from GEC's considerable existing in-house demands for microcircuits, both Avery and A. B. Dick are potential big users. So although office equipment and weighing machines look odd areas to get into, there is a direct connection with electronics and particularly the "chip". The forecast that GEC-Fairchild will be in production by 1980 was still firm at the time of writing and the initial phase of 100 people is planned to expand to 1,000 at a rate which will presumably be geared by market demand.

Both GEC and Racal are already in the microcircuit business, Racal at present only in thick-film hybrids and designing their own custom silicon i.c.s with processing by outside contractors. It is probable that Racal will set up diffusion facilities in the near future. GEC has the Hirst Research Centre for fabrication of exotic devices (such as c.c.d.s) and has a first-class thick-film hybrid plant at Marconi Space and Defence Systems at Portsmouth. I can say this with certainty, having recently visited it.

Wall-to-Wall

You don't expect to find wall-to-wall carpeting in a machine shop. Yet this is precisely what I found in the tool room of the Berg Electronics plant in Holland. Not only wall-to-wall carpeting but also a profusion of house-plants, many of them exotic varieties. A settee, armchairs and a TV set, though not present, would not have looked out of place.

Berg make connectors and the piece parts are of high precision demanding great skill in tooling for the high speed presses turning out millions of parts a day. The restful atmosphere no doubt pays off in quality of work. But wherever I went in the plant there was light and air and, above all, cleanliness. Even the plating shop was completely free of noxious fumes and the duckboards were dry. British firms please copy.

Avionics

Avionics companies get a new boost with plans for the Westland WG34 helicopter replacement for the current Sea King. Project definition contracts are already out for communications, radar, anti-submarine systems, data handling and flight control systems. Among the British companies involved are Marconi, Decca, Ferranti, Smiths and Louis Newmark. The WG34 is essentially a Royal Navy project but is expected to be also produced collaboratively in Europe, the Italians in particular having expressed an interest.

EMI's new Searchwater radar has had its first production delivery to the Royal Air Force for the Nimrod Mk 2 maritime reconnaissance aircraft.

Among avionics production units now using MPUs is the fuel flowmeter system designed by Marconi Avionics for use in the Hawk jet trainer and light attack aircraft, ordered for the RAF and for the Finnish and Indonesian air forces.

TRSB

Finally, remember the row over the proposed international microwave landing system, that finally chosen being the US Time-Reference Scanning Beam System (TRSB) in preference to the British Doppler System? Now, it looks as if TRSB is running into trouble on costs, apart from the fact that a full-scale working system has not yet been demonstrated. There could still be a chance of the British system re-emerging as a world standard.

News Briefs

by Mike Abbott

TV OR SCOPE

EXCELLENT for the engineer who likes to watch Magic Roundabout while appearing to work, is the oscilloscope designed for video monitoring applications, supplied by Gould Instruments Division to meet an order from the BBC.

The oscilloscope is a modified brighter version of the Gould Advance OS3300B with a BBC designed timebase module incorporating comprehensive video triggering facilities, which is being made by Gould under a manufacturing licence agreement from the BBC.

The new timebase generator allows the oscilloscope to be used for detailed line-by-line examination of 625-line television waveforms or to display a television picture. It accepts a standard level video signal, which may contain "Sound-in-Sync" signals and provides six different triggering modes: field 1, field 2, field 1 and 2 alternating, line repetitive, single line selectable by front panel switches (with the line number indicated on a 3 digit l.e.d. display) and line pairs in the range 16/329 to 22/335.

The triggering can be delayed continuously by up to 90µs via a multiturn potentiometer, which allows the signal to be examined in detail.

The displayed video signal may be clamped or not, as required. When the unit is used to display a television picture, the triggering point selected may be observed as a "bright up line" on the picture, enabling the waveforms to be rapidly related to the picture. The changeover from waveform to picture is effected by a single front panel switch. The modified timebase retains its normal triggering facilities, so that the instrument may also be used as a general purpose single timebase oscilloscope.

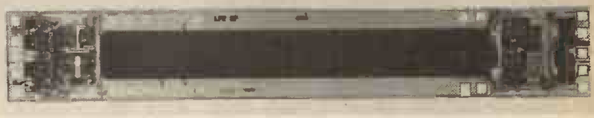
FIR FILTERS

THE CTD (Charge Transfer Device) is now a commonplace device, which is at present, more frequently found performing the function of delay line—the most obvious application. However, it is probably in the field of *application* where the more interesting developments will take place with "bucket brigade devices". Suggestions include electronic "de-wow" and "de-flutter" circuits for tape replay systems, and speech compression machines for the recording of books for the blind.

The CTD has turned out to be very powerful in filter design, around which has evolved a completely new technique giving more filter power per square centimetre than any other.

An example of this is the Reticon R5602 CTD filter i.c. (claimed to have been the first commercially available i.c. of its kind). Previously the only monolithic transversal filters for analogue signal processors were custom made large-scale integrated CCD's.

This transversal filter can do in one monolithic device the job of several boards full of components. The first four products in the R5602 family include low-pass and bandpass filters, each in a narrow and broadband version. The devices (also called Finite Impulse Response filters), are made using a 64 stage split electrode type bucket-brigade device architecture, utilising the fundamental metal-oxide-semiconductor structure as a capacitor. They use a new differential output sensing technique which offers such advantages as reduced insertion loss in the passband, simpler external circuitry and cancellation of common mode clock signals.



Reticon R5602: A family of 64 point Charge Transfer Device (CTD) Transversal Filters using the split electrode architecture. Pictured above is the narrow band low pass filter.

There are several unique features. First, they can be programmed (i.e. tuned), by simply varying the input clock frequency. Secondly, they have linear phase with no added device complexity which is essential when filtering waveforms where the information is contained in the shape of the signal (e.g. in geophysical, biomedical and transducer applications). Finally, the R5602 has a high transition, or roll-off, rate from passband to stopband that is typically greater than 200 dB/octave. These are extremely high values when compared with those of conventional multi-pole filters, and the sharp cut-off is particularly useful in rejecting close-in signals near a desired signal.

Typical applications are in generating single-sideband signals, where one sideband is rejected and the other passed, within very tight tolerances, or in data-acquisition systems, between the transducer and the analogue-to-digital converter, to band-limit the input signal without distortion.

The R5602 family comes in a 16 pin dual-in-line package with a usable sampling frequency range of 250Hz to 1MHz. Customised filters are easily and inexpensively achieved with a simple mask change.

Further information from Andy Longford, Herbert Sigma Limited, Spring Road, Letchworth, Herts.

COUNTDOWN

THE FOURTH *Intel Fair* is scheduled to take place on June 11, 1979, and will again be held at the Wembley Conference Centre.

There will be a series of seminars at elementary, intermediate and advanced levels, and an exhibition in which Intel, their distributors and customers will give demonstrations expected to reflect the state of the microcomputer art.

Rotterdam is the venue of the *Third International Symposium and Technical Exhibition of Electromagnetic Compatibility*, and the date is May 1–3, 1979. Organised by the Netherlands National Electrotechnical Committee of the IEC in co-operation with the Federal Institute of Technology, Zurich, the symposium will deal with the problems of interaction of electromagnetic energy with electronic and biological systems, and the immunity and compatibility of electronic systems regarding the electromagnetic environment. A total of 120 interesting papers will be presented, covering such subjects as ignition and gas discharge noise, and even the curious business of artificially triggered lightning.

Fee reductions for members of co-operating organisations, early registrants and students are envisaged. Contact: (Symposium) Dr T. Dvorak on (01) 326-211. Ext. 2790. (Exhibition) Mr R. E. Gerritsen on (070) 906-800.

Labex International '79 is an exhibition of laboratory diagnostic and medical instrumentation, and will be taking place at the National Exhibition Centre, Birmingham, during March 12–16. Details: 021-705 6707.

The same telephone number for details of *Electronics '79;* electronic components industry fair. This will take place November 20–23 at Olympia, London.

PE MICROPRINTER

PART 3

MARK SIMON

40 COLUMN, 5 × 7 DOT MATRIX, ELECTROSENSITIVE FOIL PRINTER.

THE FINAL part in this series of articles describes a method of testing the system gradually. It also lists a few maintenance tips for using the printer.

TESTING THE INTERFACE BOARD

Before connecting the interface board to the switched supplies, check that the correct voltages are appearing on the correct wires, and that the switching sequence is as referred to in Part 2. Remember we have to pinch the 5V supply from the microcomputer system. Switch on power supplies and move the lever to the 5V only position. We can now check the CMOS logic.

With the REED I/P open circuit (logic 1), the result of switching on should be that the motor flip flop is reset. If the REED I/P is shorted to 0V, the result of switching on should be that the motor flip flop is set. Shorting the PRINT command (PC) I/P to 0V should also set the motor flip flop. If that part of the circuit works correctly we can move on to the pick up coil and amplifier. A sinewave oscillator set at around 800Hz with an amplitude of 0·6V p.p. should be connected to the pick-up coil input. This should be sufficient to produce a rectangular train of pulses at normal logic levels from the output of the 74C14 buffer. Remember that the circuit will not work if the MC14011 CP NAND gate is a B series or buffered part, MC14011BCP.

This pulse train should now be clocking the MC14013CP D Type flip flop. This can be checked by switching the REED input between 0V and open circuit. The Q output of the flip flop should follow this switching. The return of the Q output to zero should fire Monostable 2 which resets the motor flip flop. Monostable 1 should be triggered on the leading edge of each clock pulse. Set the variable resistor connected to Monostable 1 at mid-setting at this stage. The character generator circuit can now be tested. Switch the power supply switch to the fully on position. If REED is shorted to 0V, and pick-up pulses of some kind are being supplied, the character generator chip should be outputting the pulses required to print a question mark. This is because its data inputs should be held high by the pull up resistors on the I/P CMOS buffers. See Fig. 3.1. Check the output pulses carefully, for if transients are to cause any trouble, it is here that their effect will become apparent. If any disturbance is observed it may mean looking at wiring runs and, if not too painful, circuit layout. Different character outputs can be obtained at this stage by pulling different Data buffer inputs low.

The electrode drivers can be checked at this time, for although they are not yet connected, the output voltage will be developed across the 10k collector resistors on the BD189s.

To check the printer separately simply insert some metallized paper and supply 24V to the motor contacts. The print head should move back and forth and paper should advance.

THE PRINTER AND INTERFACE

With the printer and interface connected together proceed as follows:

With all data inputs at logic 1, briefly short $\overline{PC}$ to 0V. The printer should start operation printing successive lines of question marks. The variable resistor connected to Monostable 1 can now be adjusted to give the required Print intensity.

If the printing is poor then investigate the current paths for the electrode currents—is there any resistance there? If the printing is erratic then there may be trouble caused by noise. If a scope is available look at the character generator outputs.

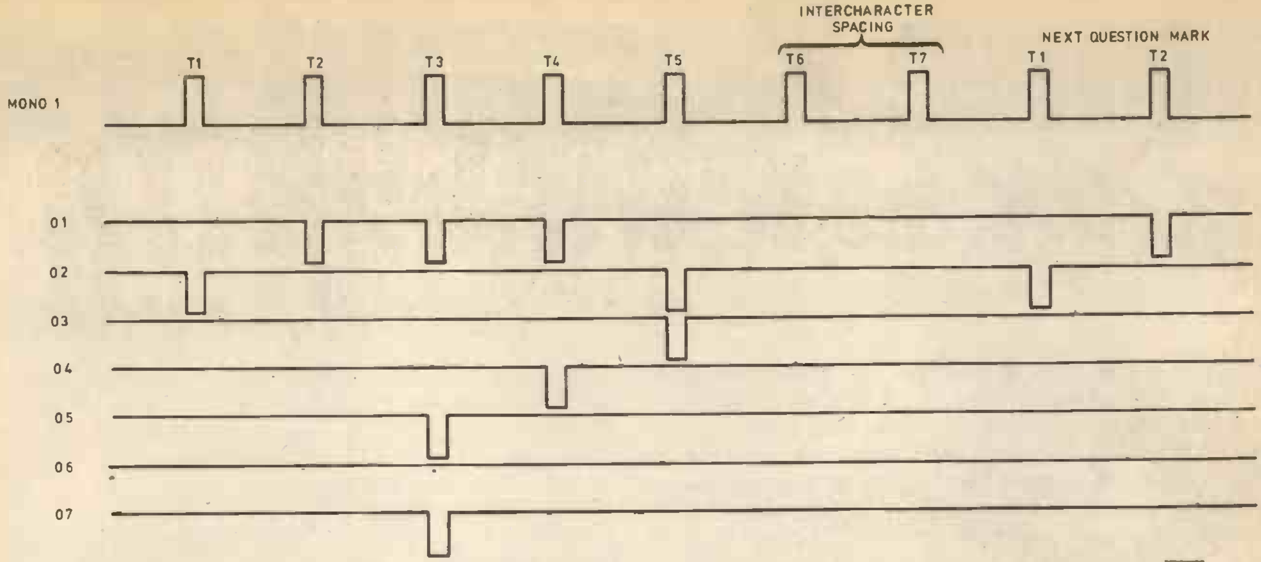


Fig. 3.1. Character generator chip O/P for all 1s I/Ps

THE COMPUTER TIE UP

Now we are ready to connect up to the Microcomputer system. Firstly it is worth loading PRINT into the microcomputer system and stepping through it to see if the output signals are being generated. It will be necessary to simulate DATA REQUEST with a switch at this stage.

If PRINT is being used alone its exit instruction (RET) should be changed to a HALT. Otherwise, on finishing, the PRINT routine the processor will RETurn to some unknown location and run amok.

Connect the printer system and switch on. As long as the $\overline{PC}$ is at logic 1 nothing should run.

Fill an area of RAM, say 10 locations with a character code, followed by an end of text character (FFH). Set HL to the address of the first character and "GO" from the beginning of PRINT.

The correct number of these characters should be printed, then the system should stop, ready for the next line. Now try inserting a carriage return (ODH) into the character string and repeating the procedure. This time when the printer hits carriage return it should stop printing until the next line, where the rest of the characters should be printed. If these tests work you should be able to write little test routines to fill areas of memory with ASCII characters then print them out.

Now the DUMP software can be loaded and run with PRINT (remember to change PRINT's exit instruction back to RET). It may be of interest to some constructors to step through parts of DUMP to see the number conversions taking place.

To save repeatedly loading the software it may be more convenient to have it "blown" into programmable read only memory. Although the software may have to be "re-origined", and the RAM addresses changed to suit your own microcomputer system.

MAINTENANCE

The prototype printer performed some fairly heavy test runs without any trouble. The manufacturer states that its useful life should be around 30 million lines. Below are listed a few maintenance pointers.

(1) Don't operate the printer without paper or with paper that cannot be advanced.
(2) After some time printing dust can accumulate in the bottom of the printer. This should be brushed out (gently).
(3) If the printer scanning speed slows down, the scanning shaft should be lubricated with light machine oil.

That concludes this series of articles. I hope those of you who build this system will find its many diverse aspects of engineering as interesting as I did. Good luck. ★

Home Computers
...the Microprocessor Miracle!

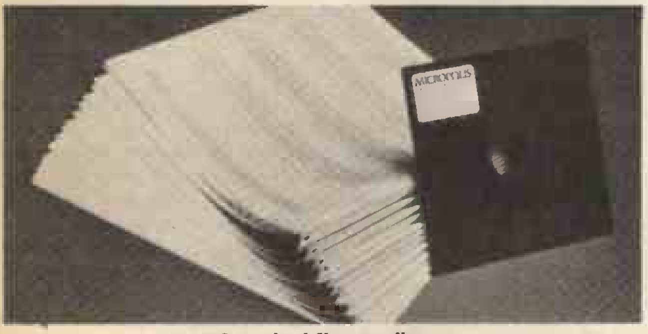
PART TWO — R.W. COLES

WITHOUT any shadow of a doubt, the ultimate home computer peripheral is a floppy disc system. "Floppy discs" are thin flexible plastic discs coated with a magnetic material and permanently sealed inside a square protective envelope. The envelope has a central hole so that the disc can engage the drive, and further holes and slots for the read-write head and the sector marker holes. The disc in its envelope is inserted edgewise into the drive, and the gate closed. Now the fun begins! Loading a BASIC interpreter from cassette takes many minutes, from disc it takes seconds. Finding a program or data file on tape is a tedious one-way search-and-rewind business; with a disc system you type the name and hey presto! it's in RAM already. Is your program too big for your RAM? With a disc system you can use overlays, so that only the currently active section of your program is in RAM at any time. When the next section is needed, it's loaded automatically in next to no time! Add to the above attributes, all the traditional advantages of magnetic storage media such as low cost, large capacity, reliability and transportable software, and you can see why the floppy disc reigns supreme in the home-computer-peripheral heirarchy. To add a disc drive or two to your system, you will need a disc controller board, and these are widely available for S100 systems. The drives themselves are electro-mechanical devices, and they come in two basic sizes:

(1) Standard-Floppies,
and (2) Mini-Floppies.

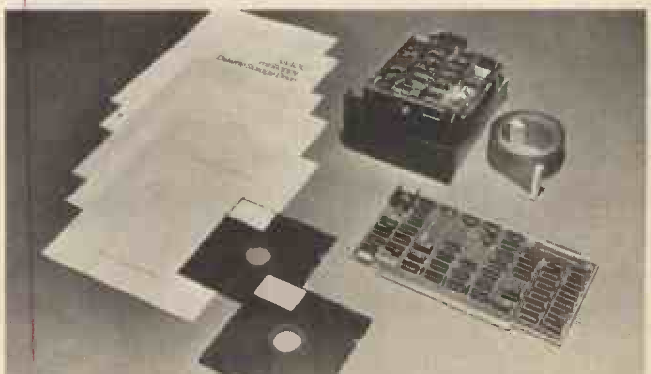
A Standard Floppy disc drive takes 8in diameter discs which can each store over 200K bytes of data. A Mini-Floppy disc drive takes $5\frac{1}{4}$in diameter discs which can each store about 80K bytes of data. Variations on the theme allow double-density or double-sided recording, which increase the capacity still further so that it is unlikely that you will ever feel cramped for space.

Cost, of course, is the big problem. Even though floppy disc systems are known as low cost storage devices in comparison with their "hard-disc" cousins from the big-computer world, they still cost several hundred pounds per drive with the controller extra. With an S100 system you can upgrade gradually, starting with a single Mini-Floppy and controller. Even this basic facility opens the door to powerful software and a really effective home-computer system which can be used as a practical, problem solving tool.


A typical floppy disc


The FD-8 floppy disc system. Available software includes a MINI-DOS routine

The Extel 950 floppy disc system


A complete floppy disc system for an S100 computer

The Micros Z80 system

SOFTWARE

A microprocessor, even when connected up to external memory, a keyboard, a VDU and all the other necessary hardware bits and pieces, is really very dumb indeed until that extra "magic" ingredient, Software, is added. Without the software, you can hit any key you like and all you'll get is a sore finger. Press the reset button if you like, but alas, no friendly message will be flashed upon the VDU inviting you to communicate. Inside the microprocessor chip, the program counter will be running, looking in vain for a set of valid instructions which are not there.

Let's assume for a moment that we really do have a machine in this condition. What is the minimum software package that we need to help the system out of its misery? Well, first we need a keyboard input routine which checks for any keys pressed and loads the appropriate ASCII character into an area of RAM we can designate as an input buffer. Next we need a VDU driver routine which will take the contents of an area of RAM designated as an output buffer and send it in ASCII to the VDU hardware. So far so good. We can now type on the keyboard and see the result on the screen, but we still have a long way to go. To permit the microprocessor to do different things, in response to typed in commands, we need a command interpreter which will examine ASCII strings for a match with one of a set of commands it has been programmed to recognise. Useful commands might be:

1) ENTER ADDRESS
2) ENTER DATA (and increment address)
3) DISPLAY DATA (and increment address)
4) SET PROGRAM COUNTER
5) RUN PROGRAM
6) LOAD PROGRAM FROM TAPE
7) SAVE PROGRAM ON TAPE

This command interpreter could be designed to recognise a number, a single letter, or a complete string of characters for each command, depending on how sophisticated we wanted to make it. An important consideration is that we should be able to add extra commands at a later date should we so wish. Of course, commands like ENTER ADDRESS would be preceded or followed by a number, and these numbers will have to conform to a convention. A common format would be a four digit hexadecimal number for an address, but we could use 16 bit binary, six digit octal or even five digit decimal numbers. It's up to us, but whatever number system we choose, we have to provide a routine to convert the ASCII characters from the keyboard (which occupy one byte per digit) into the packed binary which the microprocessor chip itself can deal with.

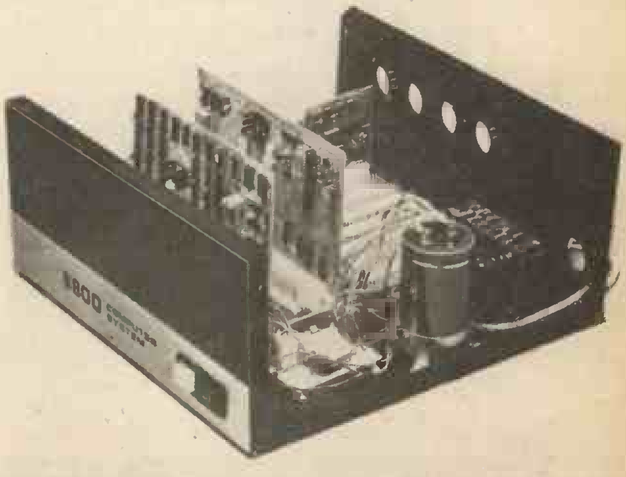
We could add all sorts of other bits and pieces, but let's stop there. The software package we have created is called a Monitor, and regardless of what other fancy software can be added, every system needs a monitor of some sort to get it started. Monitors are usually kept in ROM or PROM form, for obvious reasons, and it is this sort of software package that you have to rely on exclusively when you buy an "evaluation card" system. Using the Monitor on either an evaluation card or a home-computer, you can enter machine code programs in hexadecimal and then examine, alter, and run them. Unfortunately, writing machine code programs is a tedious business. The process of looking up the hexadecimal equivalents of MPU instructions such as ADD, LD A,B, OUT, and then keying these into the system with not a word of explanation for you to read when you come to examine the program next week or next year, is enough to put off even the keenest user!

We can escape from this tedium in one of three ways, made possible by yet more system software in the form of:

(a) An Assembler package
(b) A high level language Interpreter package
(c) A high level language Compiler package

ASSEMBLERS

Machine code programming may be tedious, but it does have the advantage of a hardware intimacy which high level languages such as BASIC, lack. This intimacy makes



The MP-68 computer system is based upon the Motorola 6800 microprocessor

machine code programming particularly valuable where the objective is to write a program to interface with some quirky piece of hardware, a printer say, or where it is vital that a program be made as fast and as memory efficient as possible. To retain the advantages of machine code programming while removing much of the drudgery, you can add an Assembler to your system. An Assembler is a sizable software package which allows programs to be entered, not in hexadecimal, but as assembly language mnemonics, just as they are printed in the microprocessor manual. This means that the Z80 program sequence:

```
POP HL
LD A, H
RLCA
```

can be typed in just as you would write it down on your program sheet and not in the hexadecimal equivalent form:

```
E1
7C
07
```

which is more compact, but meaningless when you try to decipher it later. But this is only the start. Another problem of machine code programs is the specification of jump ad-

The AIM65 from Rockwell uses a 6500 microprocessor and includes both a 20 column printer and keyboard

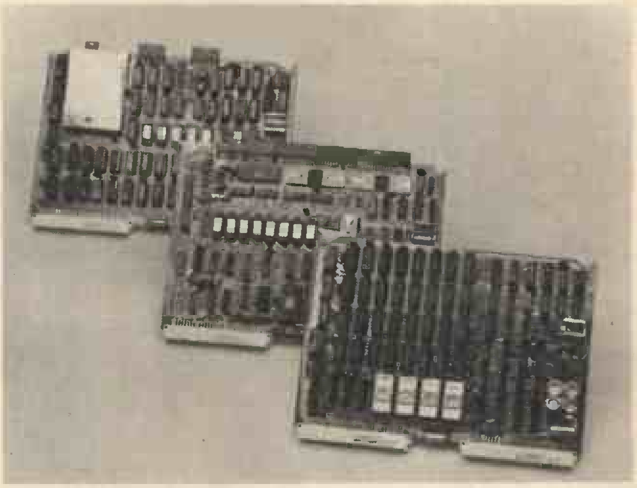
dresses, for loops and subroutines for example, which has to be done in the form of an absolute value. This is not too bad until you need to insert one extra line into your program, whereupon all the addresses after the new instruction are changed, and redefining all the JSR and JMP destinations can become a task of nightmarish proportions! To cure this problem, assemblers allow the programmer to use named addresses (called symbolic addresses) which are assigned absolute values only when the input code is processed by the assembler software. When typing in your input code (called source code) in mnemonic form, you give each destination a name, and when you want to go to the destination you simply type the jump instruction followed by the name, like this:

```
FRED:  LD A, C
       LD C, A
       JP FRED
```

When the assembler is entered (via the monitor) it makes a first pass through your source code to build up a symbol table which assigns each name an absolute address. On the second pass (Most assemblers make two passes through the source code) it substitutes the absolute address value from its symbol table wherever a reference is made to it. To add extra instructions you can now type them into your source code using a software package called an Editor, and then the assembler can be run again to process the new instructions and sort out the address changes.

INTERPRETERS

Even assembly language programming can be a drag for some applications. Suppose you want to calculate your chequebook balance, or plot a graph on the VDU, the last thing you are going to want to worry about is the precise way in which the system carries out the arithmetic and controls the peripherals at its disposal. After all you don't have to worry about the way the machine operates when you use a scientific calculator—enter a number and press the $\sqrt{X}$ key, and the answer is immediately displayed. Within the confines of the calculator chip a lengthy machine code program did the hard work, but we can be blissfully unaware of its presence. A similar technique can be used with home computers. With our Monitor program, discussed earlier, we were allowed to type in commands such as ENTER DATA which invoked lengthy machine code routines.



The SGS-ATES Euro card system is based upon the Z80 microprocessor

It is a fairly short step from this to the ability to enter whole programs using English language statements which have the effect of selecting machine code routines and stringing them together in a way transparent to the user, via a sort of super Command Interpreter. Home computer BASIC operates in this way and allows programs to be written in a high level form using selected English statements and a set of ASCII punctuation characters with defined significance. The BASIC language interpreter must reside in the system while programs are entered or run, and this means that a sizable memory is required to hold both the interpreter and the user program. The amount of memory required varies depending on the microprocessor used and the details of the particular version of BASIC to be loaded. At one end of the scale is a TINY BASIC for the 8080 which fits into only 2K bytes of memory. At the other end is Zilog disc extended BASIC which requires nearly 45K bytes! Between these extremes lie other variations and permutations, and this means that any intending home computer purchaser cannot simply say "Well, it runs BASIC so it must be a powerful system." BASICs differ in their available statements (Such as INPUT, GOTO, PRINT,) in their available functions (Such as SIN, EXP, SQR) and in their arithmetic precision. TINY BASIC is restricted to the use of integer numbers in the range −32768 to +32767, while most BASICs of 8K bytes or more can give at least an eight digit decimal arithmetic precision and have a wide dynamic range due to the use of scientific number rotation. The words to look for in the specification are:

"Integer only" (Like TINY BASIC)
"Floating Point" (Full arithmetic capability)

BASIC DETAILS

BASIC is a problem orientated language rather than a machine orientated language, and in theory BASIC programs written for one machine should run just as well on any other. In fact this is not strictly true because there are so many versions of BASIC around and these are not always compatible. Nevertheless, you only need to learn BASIC once, any differences between individual versions can be assimilated very quickly when the need arises.

A program in BASIC consists of a list of numbered lines or statements. For example:

```
  5  REM *** CHEQUE BALANCE ***
 10  PRINT "ENTER OLD BALANCE"
 20  INPUT B
 30  PRINT "ENTER CHEQUE AMOUNT"
 40  INPUT A
 50  LET B=B−A
 60  PRINT "NEW BALANCE IS" B
 70  PRINT "ANY MORE CHEQUES?"
 80  INPUT C $
 90  IF C $="YES" THEN 30
100   END
```

Once a program has been typed in, it can be run by typing RUN. Changes to the program can be made by retyping a line or by inserting new lines between old lines, a process made easier by the numbering of lines in increments of ten to start with! A line can be erased by typing in its line number followed by RETURN.

If a statement is typed in without a line number, it is executed as soon as RETURN is pressed. This makes a BASIC machine work like a calculator for simple arithmetic calculations, e.g. typing in

PRINT SQR 14·7 (RETURN)

results in the square root of 14·7 being displayed on the VDU immediately. Another use of the immediate mode is in programme debugging. If a line in your program is giving trouble, entering the line without a line number will allow immediate execution so that you can locate the problem easily. Before a line of code is interpreted it is checked for correct syntax. If you have made any mistakes, such as having unbalanced pairs of brackets in an expression, an error message will normally be displayed.

BASIC, then, is an ideal language for beginners (After all, BASIC does stand for Beginners All Purpose Symbolic Instruction Code!) but its capabilities should not be underestimated. Many professional programs have been written in BASIC, and you may progress a long way in the field of computer science before feeling the need for something better!

BASIC PROBLEMS

The problems of BASIC stem mainly from the fact that it is an interpreted language. One problem is that the Interpreter program and the user program both have to be in memory at the same time so that a lot of memory space is needed. This problem is perhaps not so valid in these days of cheap and plentiful semiconductor memory, as it used to be in the days of expensive core stores. Perhaps the most serious problem with BASIC, and with any other interpretive language come to that, is its speed. The program is not represented by a long list of ready to run machine code instructions in memory, but as a series of ASCII strings as they were typed in. To carry out the operations intended by the programmer, the Interpreter (A machine code program) has to analyse each line and then call other machine code routines to do the necessary donkey work. As you can imagine therefore, the BASIC language is several times slower in operation than some alternative techniques, particularly assembly language for example, where the mnemonic strings typed by the programmer are converted into a machine language program before the program is run. Fortunately, the speed of BASIC is not a limiting factor for most home computer applications, and its ease of use more than makes up for its shortcomings in the speed department!

COMPILERS

A Compiler is a high level language software package which is used in a similar way to the Assembler package mentioned earlier. Unlike an Interpreter, the Compiler software does not have to be available in the system at run time, rather it is used to process the high level language statements in the source program to produce a new machine code version of the program which can then be run by itself. A typical compiled high level language is FORTRAN (FORmula TRANslator) which is widely used for scientific applications. Programming in FORTRAN goes like this:

The SOL terminal computer from Processor Technology is an S100 compatible system using the 8080 microprocessor

First, the high level program statements are typed into the system. These statements look somewhat similar to their BASIC counterparts.

Next, the Compiler software analyses the user program and produces an equivalent machine code program called the object program.

Finally, the object code can be loaded into memory and executed, whenever it is required.

This is the same sort of sequence as is used with an Assembler, except that in the assembly language case the source program starts out in mnemonic code and the machine code object program has a one for one relationship in terms of numbers of instructions. Compilers are a lot more sophisticated than Assemblers because they are able to convert compact high level language statements into much longer object code routines which do not of course have a one to one relationship with the source program.

DEBUG

Debugging compiled programs is more difficult than is the case with an interpretive language like BASIC. Every time a bug is found, the source program has to be modified and the Compiler re-run before the effect of the change can be tried out. For this reason it is better to cut your programming teeth on BASIC rather than FORTRAN!

The advantages of a compiled language are not hard to find:

1) Because the Compiler need not be resident in the system at run time, memory space is used more efficiently.
2) Because no analysis is done at run time, compiled languages usually operate several times faster than interpreted languages.
3) The object code is all that has to be supplied to a second user of the program. This makes valuable programs more secure.

OTHER LANGUAGES

Of course, FORTRAN is not the only language that is compiled, and although it is in widespread use elsewhere, it is probably not going to become very popular on home computer systems, where BASIC still reigns supreme. You can even get hold of a BASIC compiler, but this is aimed more at the industrial software market than the home-computer scene. A more recent and useful language for home-computer systems is PASCAL which actually uses interpreter and compiler techniques to produce the final object code. With PASCAL the Compiler turns source statements into a special low level code called P-code, the P-code is then run interpretively on the host machine. The Interpreter required in this case is quite small, but it does have to be resident at run time, unlike the PASCAL compiler. The advantage of this technique is that the Compiler itself does not have to be rewritten for every new microprocessor chip or main-frame, only the small interpreter need be different in each case. This means that programs written in PASCAL can be run on any other machine with a P-code interpreter without the need for re-compilation. Apart from its operational advantages, PASCAL is also hailed by some computer scientists as a great step forward because it encourages better, "Structured", programming in the users. Some home computer systems are already using PASCAL, and we may see more of it in the future.

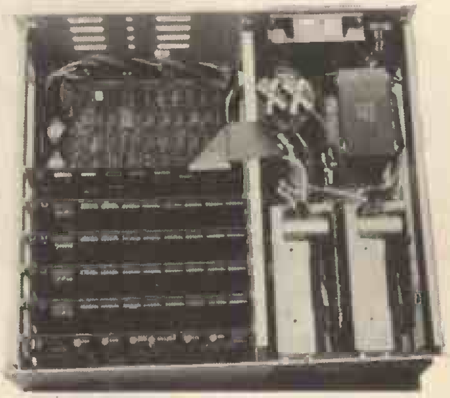
The Horizon microcomputer has dual mini floppy drives and is available with a Disc Operating system

DISC SOFTWARE

Once a floppy disc system has been added to a home computer system many enhanced software features are possible. Assemblers, Interpreters and Compilers can certainly be disc based, but perhaps the most powerful feature available to the lucky disc user is a software package known as a Disc Operating System or DOS for short. A DOS is a sort of super disc based monitor with a menu of powerful commands such as COPY (disc)MOVE (file) DUMP (file to an output device) SET (baud rate etc.) and many others which can be invoked by name from the keyboard. Each of these powerful commands is stored on the disc as a ready-to-run program. Typing in the command name is sufficient to load the command program from disc and set it running. A ROM resident monitor or operating system which featured all these commands would be much too large and therefore impractical.

The best example of a home computer DOS is probably CP/M from Digital Research which runs on 8080 or Z80 systems and features an Assembler, Editor, and hexadecimal Debug package as standard, with lots of other bolt-on-goodies also available from the same source.

The aim of this whistle-stop tour around home computer hardware and software has been to provide all P.E. readers with a basic grounding in home computer terminology and practice. Home computers are not a passing fad, they are here to stay, so why not go along to your local computer store and try one out? One word of warning though, if you get bitten by the programming bug, you may never be the same again.



An internal view of the Horizon

CHECK-LIST

Before rushing out to buy a home-computer system, remember that it is a big investment. The following check-list may help in the evaluation of any particular system on offer.

(1) Does it feature a high level language?
(2) Is the language a "tiny" language (suitable for games but not maths) or is it a "standard" or "extended" language (suitable for most purposes; but examine available statements and arithmetic precision).
(3) Does the system come complete with ACSII keyboard and VDU display or TV modulator?
(4) How many characters can the VDU display at once, and can it handle graphics or colour?
(5) How much RAM has it, and is this *easily* expandable?
(6) Has it got software in ROM or must it be loaded into RAM? (In which case, more RAM is needed.)
(7) Is it well supported by commercial software? (Interpreters, assemblers, maths packages, business programs, games, etc.).
(8) Can you expand it by adding: A printer, extra cassette unit, floppy discs, homebrew hardware, etc?
(9) Is it well made and built to last?
(10) Is a service network available?

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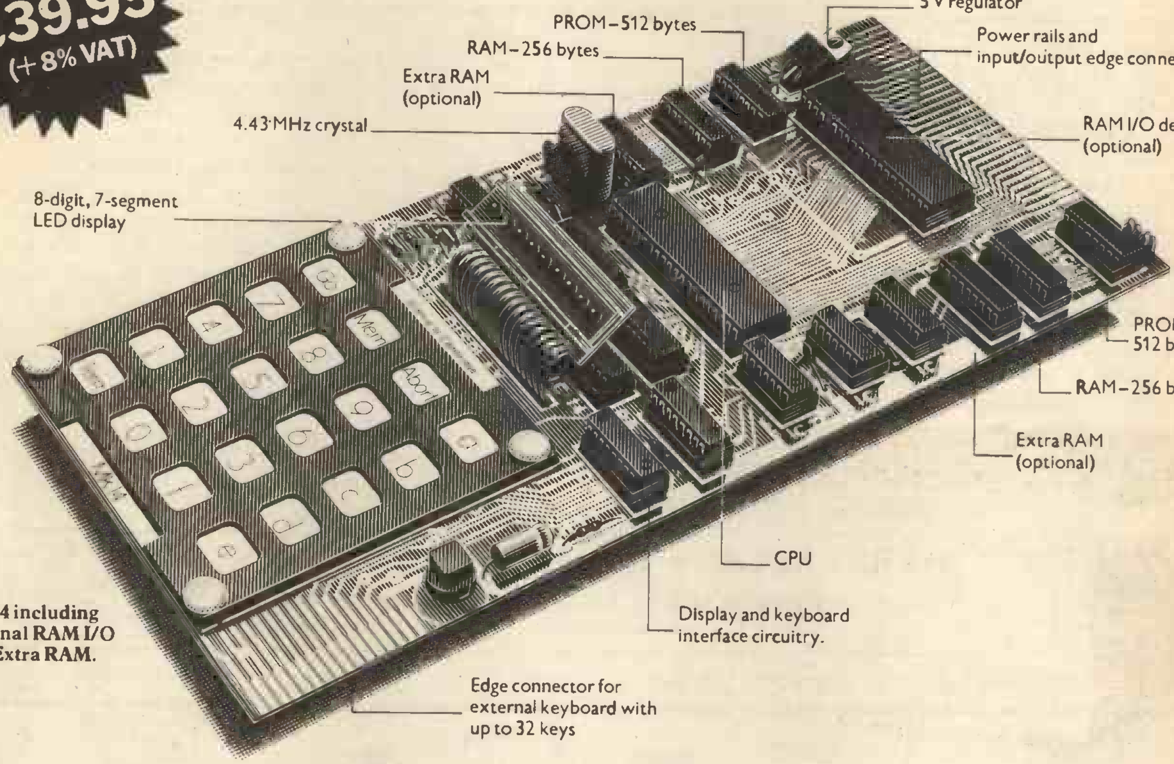

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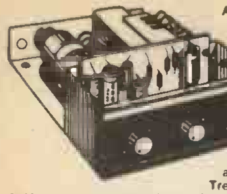

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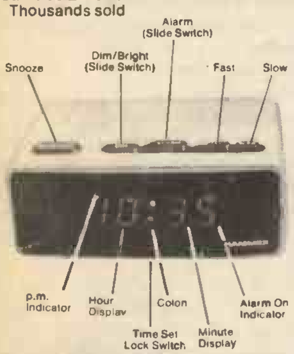

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News Briefs

by Mike Abbott

WALKY TALKY TERMINAL

INSTANTANEOUS access to computer information from a pocket-sized portable radio is provided by the new RDX 100 portable Data Terminal developed by Motorola. The RDX is a lightweight high-powered FM transmitter/receiver, fully self-contained, currently designed to be compatible with the IBM 360/370 Information Display System for data entry, retrieval and update applications. The radio has been developed for both indoor and outdoor use, requiring no telephone lines, interconnecting cables or external power source.

The RDX Data Terminal System comprises the RDX 100 Portable Terminal, a duplex FM radio base station and an RDX 1100 Control Unit, which can handle up to 32 portable terminals. Two-way, real time communications between the portable terminal and the computer is accomplished by an FM radio link between the terminal and the base station, and a synchronised landline link between the RDX 1100 Control Unit and the computer.

The radio operates in the UHF band, sending and receiving information from the base station at 80 characters a second, while the RDX 1100 Control Unit communicates with the IBM computer system at standard transfer rates from 1200 to 9600 bits per second. Because of its versatility, Motorola expects its RDX system to find a wide spread of applications, such as Freight Traffic Management, Stock Control, Materials Handling and Load Distribution Management.

One reason for its versatility is the optional detachable, solid state light pen powered from the portable terminal. Ideal for data entry applications, the RDX Light Pen permits very rapid and accurate bi-directional entry of bar-coded data. Utilising Code 39 (alphanumeric bar code), product information such as item, location, price, data and other descriptive information can be read by the RDX. Because this light pen is fully alphanumeric, existing product nomenclature can remain unchanged, eliminating the need to modify existing (or to develop new) product coding systems.

The system is expected to become available in the UK soon.

FLOPPY SADDLE FOR YOUR PET

A TWIN mini floppy disk system designed to preserve the integrated package approach adopted by Commodore for their Pet personal computer, has been released by Midland Micronics Ltd. of Solihull.

Pictured below, the M.M.3 floppy disk system is seen mounted saddle style over Pet's VDU to give data access nearly 1,000 times faster than by the internal cassette system.

Connection is via the Memory Expansion Socket, but still allows RAM expansion, and the additional instruction set for addressing the disk from software or keyboard is held in a PROM supplied with the system.

The disk controller itself uses a microprocessor, permitting self test operations, and the mini diskette media can be flipped for recording on both sides.

PRINTER

ANOTHER peripheral for Pet is a low cost business-quality printer which interfaces directly and is now available from GR Electronics Ltd. of Newport, Gwent. Based on the IBM 3982 "Golfball" unit, it gives full ASCII facilities with the ability to change typefaces and founts to suit specific applications.

The Petprint 3982 printer will copy letters, invoices, program listings, etc. in caps and lower case either as set up on the computer's VDU screen or input through the cassette unit. Printing speed is 15 char/sec and line length 130 characters, with a 10 char/in pitch which may be modified to 12 pitch if required. The printer is driven from the Pet's user port (not the IEEE interface) and its operation is controlled by a machine code program supplied on cassette. This gives the user flexibility in code conversion and timing as well as carriage return, line feed, tab and backspace functions.

When loaded into the Pet, the printer program occupies less than $\frac{1}{4}$K of store and will not normally be affected by loading of further information through the cassette unit. Routines included in BASIC are for listing of Peek/Poke characters, solenoid codes and characters actually printed. A further facility is a step/print function which allows "mapping" of other printing elements.

The printers themselves are "second-user" heavy-duty units, regularly maintained during their initial service life as satellite printers in a large distributed system. They have been reconditioned by an IBM specialist, from whom service and repair facilities will also be available. The price with fitted interface and software cassette is £475.

OBITUARY

IT IS with regret that we announce the death of John Miller-Kirkpatrick at the age of 31. A man with great ability, he successfully designed and marketed the Scrumpi Microcomputer system until his recent illness. We offer our sympathy to his family and friends.

CONSTANT CURRENT SOURCES

D.F. BOWERS B.Sc.

IN THE field of analogue circuit design, it is often necessary to generate constant electrical currents. One example of this is capacitors being charged with constant currents to produce linear ramp waveforms. Constant current (dynamic) loading improves the voltage gain of common emitter transistor stages and the linearity of common collector ones. Constant currents can compensate for the internal resistance of Zener diodes, and in conjunction with resistor "ladders" can produce accurate programmed voltage drops.

Modern d.c. amplifiers make extensive use of constant-current biasing, particularly in the input stages where this form of biasing improves the common-mode and supply line rejection ratio. Constant current sources also find more mundane applications such as nickel-cadmium battery charging.

Before looking into methods of achieving constant currents, it is informative to examine the necessary design criteria.

WHAT IS A CONSTANT CURRENT SOURCE?

Fig. 1a shows the block diagram of a current source. The current I is fixed and is shown flowing in the conventional (positive to negative) direction. Fig. 1b shows two commonly used symbols for constant current sources, in both cases the arrow indicates the direction of conventional current flow.

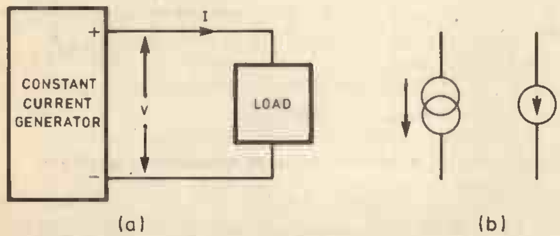


Fig. 1a. Block diagram of a current source
Fig. 1b. Constant current generator symbols

As with all black-box devices, we can specify the output of Fig. 1a with two parameters, voltage and current. The current, of course, is fixed and for this to be true the voltage must therefore be dependent on the load resistance,

i.e. $V = IR_L$ where V is output voltage
I is the constant current
R_L is the effective resistance of the load at that current

To ensure that is the case, the output impedance must in theory be infinite and with no load the output voltage should also be infinite. In practice, of course, neither of these parameters can be perfect, and figures for internal impedance and maximum output voltage are quite often used to specify the performance of a particular circuit. Another method is to specify a so-called output compliance, where the current is guaranteed to stay within a certain tolerance over a given range of output voltages. For example, a current generator of 10mA ±1 per cent working over a 10V range would require an output impedance of greater than 50k.

DESIGNING CONSTANT CURRENT SOURCES

Unfortunately, constant currents are not quite as easy to generate as constant voltages, since devices such as constant current batteries do not exist. One way of getting round this is to use a large resistor in series with a voltage source (Fig. 2).

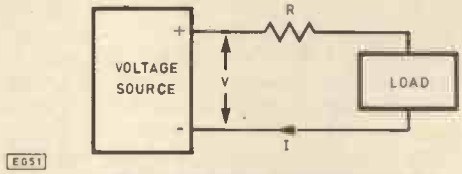


Fig. 2. Simple current generator

To satisfy our 10mA ±1 per cent over a 10V range, R would need to be 50k, but V would have to be 500 volts. The circuit would also waste a minimum of 5 watts of power, only 100mW of which would ever be used in the load. Clearly this is a rather impractical solution.

TRANSISTOR SOURCES

The bipolar transistor when connected in a common emitter configuration acts as a type of current generator. In theory, for a given base current the collector current will be constant, the relationship between the two currents being β, the current gain. The value of β (like all transistor parameters) has the unfortunate habit of changing with temperature variations, so a little complication is necessary in a practical current source. Fig. 3 shows a current source of the type often used for biasing Zener

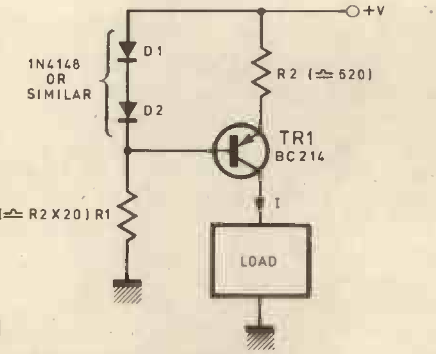


Fig. 3. Transistor current source

diodes (for example). Diodes D1 and D2 apply a voltage fixed at about −1·3 volts to the base of TR1. After the Vbe of the transistor has been subtracted, around 0·65 volts will be developed across R2 causing a current of 0·65/R amps to flow through the load, because of the transistor gain, and hence we have a constant current source, easily adjustable by changing R2. The lower voltage limit is the negative supply voltage, and the upper limit is set by the voltage drop across R2 plus the saturation voltage of TR1. Note that this circuit can also provide negative current flow (current sinking) by using a *n.p.n.* transistor and reversing all polarities. The forward diode voltage drop has a temperature coefficient of −2mV/degree centigrade which causes some drift of current with temperature change; applying a more accurate reference to the base of TR1 does not really help because a similar drift also applies to the emitter voltage of TR1. One method of alleviating this problem is to replace D1 and D2 by a forward biased gallium arsenide-phosphide l.e.d. The l.e.d. has an almost equal (−2mV/degree centigrade) temperature drift to the Vbe of TR1, but around a volt extra forward voltage drop, producing a nearly constant 1 volt drop across R2.

For more accurate work, certain other factors must be taken into account. In particular, the collector impedance of a bipolar transistor is not all that high, usually around 100k for large signals, and also the emitter resistance of the transistor cannot be ignored. Additionally, a parameter known as the reverse transfer voltage ratio causes modulation of the effective base width (emitter resistance); all of these effects combine to reduce the output voltage compliance, and are extremely difficult to compensate for. To produce accurate current sources, it is necessary to make the circuitry independent of these parameters.

USING OPERATIONAL AMPLIFIERS

The precision current sink shown in Fig. 4 uses an operational amplifier to "design out" the awkward transistor parameters. As with all operational amplifier feedback circuits, stabilisation is achieved when the operational amplifier inputs are at equal potential. Thus the voltage Vref must be impressed upon R. This

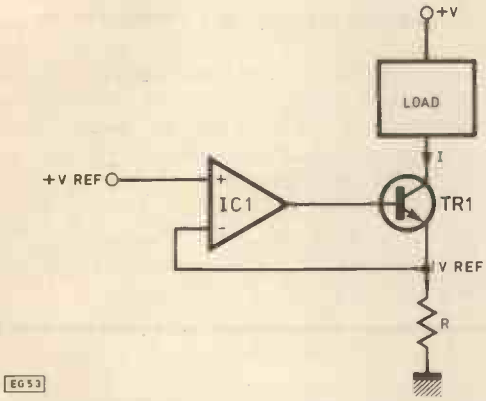


Fig. 4. Precision current sink using an op amp

causes an emitter current of Vref/R to flow, and neglecting TR1 base current all this must flow through the load, producing a constant current (provided Vref is constant). Vref which should be kept quite low (≏ 1V) to keep the voltage compliance range as high as possible, could be derived from a Zener diode or other reference source. Circuits of this type are often called transconductance amplifiers, since they act as voltage/current amplifiers with a gain of 1/R amps/volt.

Two problems can arise with the circuit of Fig. 4. Firstly, a little of the current through R will actually flow into the op amp inverting input. If the current I is high, this will usually be of no consequence, but for low currents the operational amplifier should be an FET input or superbeta type. A certain portion of the emitter current also comes via TR1 base, and this constitutes an error (1 per cent with a transistor gain of 100) since the base current does not flow through the load. Replacing TR1 with a Darlington greatly reduces the error, and if the Darlington pair has an FET for its first transistor, the error will be almost zero.

Note that despite the extra transistor, operational amplifiers compensated for unity gain (such as the 741) will usually be stable in this configuration, since no extra loop gain is introduced.

BIPOLAR TRANSCONDUCTANCE AMPLIFIERS

Although the circuit of Fig. 4 can be adapted to source current as well as sink it (using a *p.n.p.* transistor for TR1 and a negative Vref) it is sometimes necessary to accommodate both polarities of Vref (and hence output current) with a single circuit. Rather complex versions of Fig. 4 can satisfy this requirement, but for low currents easier solutions are available. Of course, if the load is fully floating, the fact that the current through the feedback path of an operational amplifier can be kept essentially constant can be used (Fig. 5). This is often made use of in

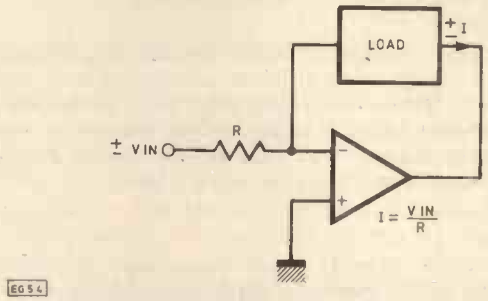


Fig. 5. Simple feedback current generator

integrator circuits (where the load is just a capacitor) but if the load is not fully floating, an alternative solution must be found.

The basic bipolar current generator (transconductance amplifier) shown in Fig. 6 is formed from a single operational amplifier. If the Ierror current is very small (i.e. R3 + R4 very

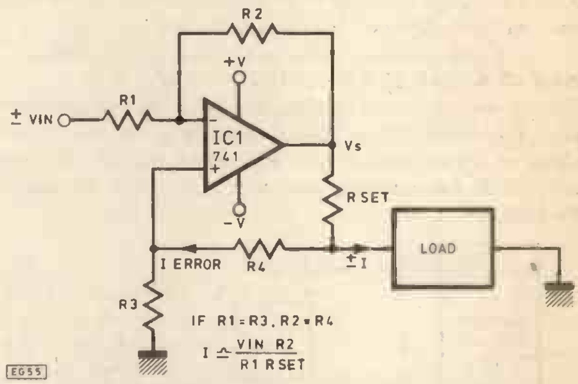


Fig. 6. A bipolar transconductance amplifier

large) then a constant current will flow through the load provided a constant voltage drop can be maintained across Rset. If R1 = R3 and R2 = R4, then any voltage at the output will be fed back to the non-inverting input in the correct proportion to ensure this condition, and the output current will be Vin/Rset × R2/R1, which can be easily adjusted with Rset. This holds true for output voltages less than ±(Vsat − Iout Rset) where Vsat is the maximum output swing of the operational amplifier. The highest value of Iout is naturally limited to the maximum

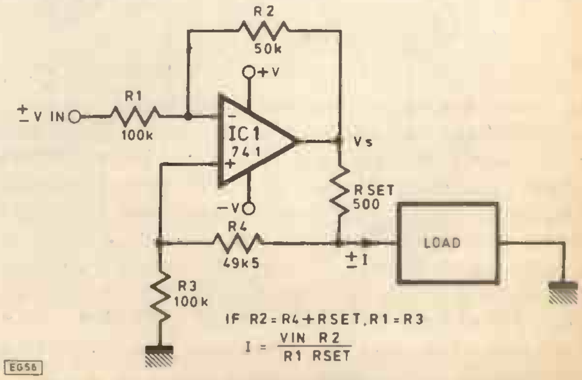


Fig. 7. An improved transconductance amplifier

operational amplifier output current. If the Ierror current is large enough to cause problems, the circuit of Fig. 7 can be used. In this circuit, the gain is adjusted to compensate for the Ierror current and for the highest accuracy very close tolerance resistors should be used. Adjustment of this circuit is not easy, since all resistor values are interrelated. The values shown are for a gain of 1mA/volt. Note that the load need not necessarily be earthed, but can be connected to any potential that maintains Vs within the operational amplifier voltage swing limit.

OPERATIONAL TRANSCONDUCTANCE AMPLIFIERS

Another way of obtaining a bipolar constant current source is to use an operational transconductance amplifier such as the CA3080 (Fig. 8). This device is designed to give a current output (up to 500μA) from a voltage input. The gain is given by $\triangle$ Vin × gm amps/volt where $\triangle$ Vin is the voltage between the input terminals and gm $\simeq$ 19·2 × Iabc for the CA3080.

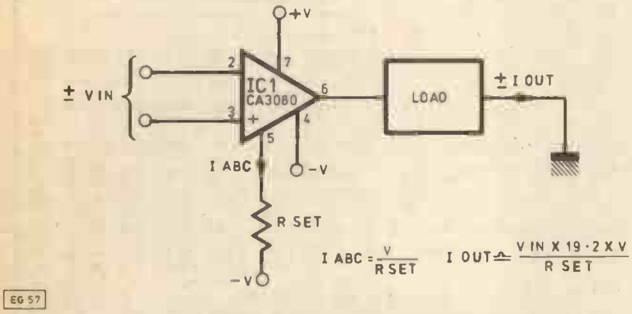


Fig. 8. An operational transconductance amplifier

Other types of current amplifier such as voltage current transactors (VCTs) have been designed, but their application is not usually appropriate to the design of simple current generators, and in any case the latter are not yet commercially available.

FETs AS CURRENT SOURCES

If after all this you are puzzled as to why some enterprising manufacturer has not brought out some simple current generator devices (akin to Zener diodes) then you will be pleased to hear that Siliconix market a range of two terminal devices, often referred to as "constant current diodes".

Although ultra high precision cannot be achieved with these devices, they make very useful bias sources or dynamic loads. These devices use FET technology, and can in fact be made using ordinary junction FETs (such as the 2N3819). Fig. 9a shows the principle.

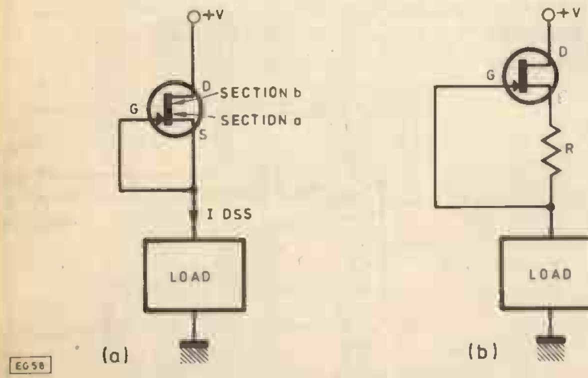


Fig. 9. Constant current "diode" principle

When sufficient reverse bias exists on the gate of an FET, the current through the channel starts to reduce. If the gate and source are connected together, then current will increase until the voltage dropped across the internal section of the source channel (section a) exceeds the required gate voltage. At this point, the current will be held almost constant. The actual value will depend on the channel resistance and pinch-off voltage of the particular FET, and is known as Idss. This value varies greatly from device to device with normal FETs, and for a 2N3819 can be anywhere from 2 to 20mA. The current can be reduced by inserting a resistor in the source of the FET (Fig. 9b).

VOLTAGE REGULATORS AS CURRENT SOURCES

Occasionally, current sources are required to deliver quite heavy currents (such as with battery chargers). Fig. 10 shows how a standard voltage regulator i.c. can be used to provide this function.

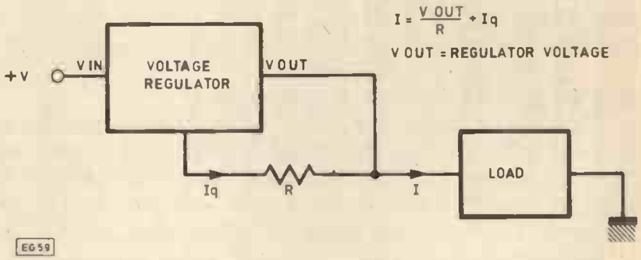
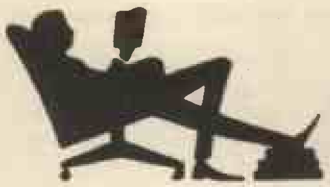


Fig. 10. A voltage regulator as a current source

The regulator ensures a constant voltage across from Vout to ground, and this causes a current of Vout/R to flow through R (and hence through the load). Added to this we have the regulator quiescent current (Iq) which is typically several milliamps and usually constant enough to cause no problems. Low voltage regulators should be used to increase the output voltage range and to keep the power dissipation in R to a minimum. Currents of several amps, depending on the regulator, can be provided in this manner.



BOOK REVIEWS

UNDERSTANDING ELECTRONICS

By R. H. Warring
Published by Lutterworth Press
175 pages. Price £3·95

THIS book attempts to explain in everyday language basic electronic principles and behaviour of simple circuits. It is an interesting book, both to the layman for the simplicity and clarity of the explanations, and to the qualified reader for the ingenuity in avoiding recourse to mathematics. The reader is asked to accept on face value only the few circuit properties which defy this form of treatment.

The book contains much useful information regarding component types, their construction, marking, mounting, etc. One glaring omission is any mention of the principles of negative feedback, the basis of every modern amplifier circuit.

J.F.G.

Semiconductor UPDATE...

FEATURING : TL496C 8202 IRF 100 IRF 305

R. W. Coles

PORTABLE POWER

Ever had the problem of providing power for a small portable unit that needs the regulation 9 volts? Easy you may say, bung in a PP3 or a PP6 battery and the problem is solved. These days though, batteries of that sort are expensive items and there may be a better way to solve the problem.

Rechargeable Nickel Cadmium cells, for example, are now freely available, and although they are initially more expensive than primary batteries, their long life can more than make up for that. Trouble is, while these rechargeable cells are great for one or two cell operation, stick to the requirement for the full 9 volts and at 1·2 volts per cell you've got an expensive battery.

To get the best out of rechargeable cells for calculators, radios, metal detectors and so on, what we need is a simple circuit which will step up the low voltage from a couple of A.A. size cells to a respectable 9 volts. Oh!, and we need a built-in recharging circuit too, so that with the aid of only a small step down transformer, we can give our cells an overnight boost, or even let them trickle charge while we are using the unit indoors.

I don't suppose you will be too surprised when I tell you that somebody has put all of the necessary goodies into an itsy-bitsy 8 pin mini-dip package, to make the job easy for us.

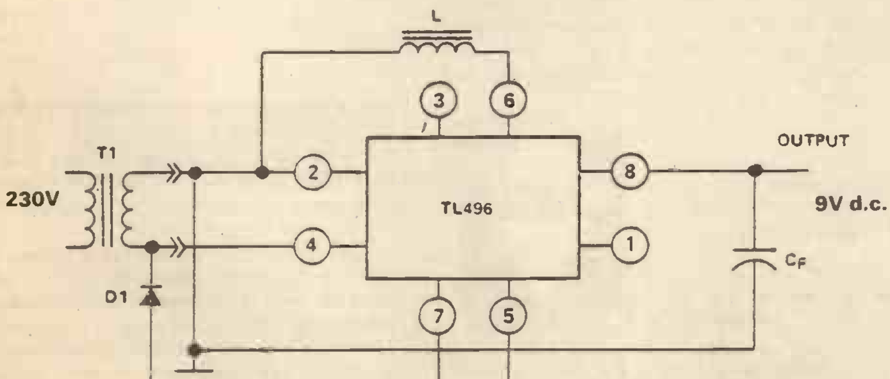
"Somebody" is no less than Texas Instruments, and the device in question is the **TL496C,** termed a 9 volt Power-Supply Controller. All you need in addition to the TL496C is an IN4001 diode, a 330µ capacitor, a 50µ inductor and of course a couple of Ni Cad cells.

To recharge the cells you will also need a mains transformer with about a 6 volt r.m.s. secondary, but there is no need to build this into the portable equipment if you don't want to.

When running off the batteries, the TL496C acts as a switching regulator to generate the required 9 volts with the aid of the inductor.

When connected to the mains, an internal diode rectifies the positive half cycle and feeds it to a 9 volt series regulator to maintain the output. At the same time, the negative half cycle is rectified by an external IN4001 and used to recharge the batteries—clever, eh?

With two cells connected, you can get up to 80mA at 9 volts at 66 per cent efficiency. With a single cell, this drops to 40mA but the efficiency remains the same. At last a small, cheap i.c. which is down to earth and practical!



TWO-CELL OPERATION

T1: V_{sec} = 6·8V r.m.s. typ., R_{sec} = 11Ω typ.
D1: 1N4001
L: 40 to 50µ, Q≈3, R < 0·15Ω
C_F: 330 to 470µ, 10 V electrolytic

REFRESHES THE BITS OTHER PARTS CANNOT REACH!

Dynamic RAMs, such as the 4K 2104, the 16K 2117 and even the new Texas 64K device, have a problem. They keep forgetting. Not such a healthy characteristic in devices which are, after all, purchased for their *memory* capability!

To make matters worse they forget everything in just a few milliseconds, and have to be reminded every 2 milliseconds about just what it was they were supposed to remember!

This apparently devious behaviour is due to the fact that in dynamic (as opposed to static) RAMs data is stored as a charge on the gate capacitor of a MOSFET. This charge leaks away, but 2 milliseconds is a long time to a microprocessor, and the reduction in size and power dissipation possible with dynamic RAM techniques makes them cost effective for large memories.

To prevent the loss of data, the memories are "refreshed" every 2 milliseconds or so with the aid of external circuitry which can get *very* complicated, especially in systems using 16 pin RAM chips where the address lines have to be multiplexed too.

If you are contemplating the construction of a big memory for use with your home computer, hold everything! Using dynamic RAMs is now not only cheap but simple too, thanks to the **8202** from Intel. This new 40 pin chip puts the whole of the refresh circuit, *and* the address multiplexer into one easy to use package.

No need to wire up arrays of TTL gates and refresh counters, no need to worry about what happens to memory refresh while DMA (Direct Memory Access) transfers take place, the 8202 takes care of it all. It'll handle a full 64K of memory too, enough for a *very* capable "Star-Wars" program!

KILO-WHAT?

Some time ago I extolled the obvious virtues of the new Siliconix VMOS power FETs which eliminate many of the disadvantages of bipolar power transistor technology while providing CMOS compatibility and the wherewithal to switch 2 amps in just 10 nanoseconds.

International Rectifier have now joined the power MOSFET brigade with a couple of devices with a very impressive specification.

The **IRF 100** is rated for 16 amps at 80 volts and has an "on" resistance of just 0·2 ohms maximum.

The **IRF 305** is rated for "only" 5 amps but (hold on to your rubber mat!) at no less than *400* volts!

Both devices can, in consequence, switch over a *kilowatt.* Just the job for that transistorised arc welder you always wanted to build!

... a selection from our postbag

Readers requiring a reply to any letter must include a stamped addressed envelope. Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

Extravagate

Sir—The article in the January issue's *Ingenuity Unlimited* section of P.E., describing a method of adding upper and lower bars on digits 6 and 9 of 7447 display drivers, is somewhat extravagent on gates. For the benefit of those readers who have not seen the method generally employed, these are the details:

Since the 7447 is an "open-collector" device, other similar devices may be connected across the outputs, using the "wired-or" mode.

Fig. 1

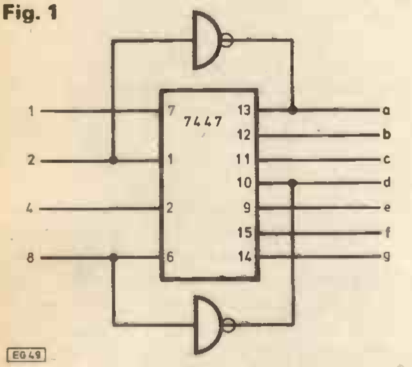


Fig. 2

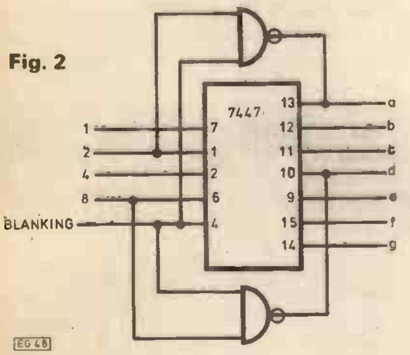


Fig. 1 shows how just two inverters from a 7405 (5V) or 7406 (30V) hex. open-collector may be used. This arrangement does not allow the "blanking" facility to be used; if it is required, the circuit of Fig. 2 should be used. This method uses two gates from a 7403 (5V) or 7426 (15V) quad. two-input open-collector NAND gate. Both methods allow more displays to be driven from fewer packages.

Unfortunately, I cannot claim any originality for these circuits, as they are too well-known in the industry.

M. A. Priestley, B.Sc.,
Edinburgh.

Symbolism

Sir—A few comments on P.E. and circuit diagram symbols:

1. The new component value labelling system is a good step. However, be warned that for inductors, 100m *could* be ambiguous—Rank Service Spares use the suffix "m" in place of "μ" for capacitors. It's unlikely, of course, that an inductor and a capacitor would be confused—but it is worth while remembering that 100m could be interpreted as 100μ by some!
2. Keep your present symbols for components. The habit of naming transistors "Q" etc. instead of "T" or "TR" is terrible, after all, it's not a "Quansistor" now is it? Unusual symbols make reading very difficult, as do non-standard layouts of circuit diagrams. There is no quibble at all with your present circuit diagrams or symbols. Change for change's sake is all too prevalent today—and I don't need it.
3. The current craze for superfluous verbiage worries me, e.g.
   This moment in time = this moment
   Visible gallium arsenide red indicator device = l.e.d.
   Advanced Technology = standard electronic circuitry
   Total solution } = an elegant
   Total systems capability } solution?

Please let it stay on the other side of the Atlantic!

So to end, broadly speaking, keep P.E. as it is. Please try to avoid that which is insubstantial, trendy and "commercial" in character; and we speak British English here—and expect to read British English—not mid Atlantic slang.

B. J. Duncan,
Tattershall, Lincoln.

The above is an extract from a very lengthy letter on P.E. and other magazines from Mr. Duncan.

A Pointless Exercise?

Sir—Full marks! for using the "pointless" method of recording component values (6k8, 4μ7, etc.) and for using "nano" for capacitor values where appropriate.

I find no more difficulty visualising that 4n7 = 4700p = ·0047μ than visualising that 6k8 = 6800Ω = ·0068M.

Full marks! also for *not* using those silly boxes to represent resistors. Symbols, to me, should be functionally descriptive, and I am sure that the zig-zag is better for a resistor than any little boxes.

More power to your elbows, gentlemen.

Chris Finn, C.Eng.
Southwood Park
Beverley

Sir—A pointless exercise, you can say that again!!!! At the moment all the capacitors in my service kit are clearly marked. ·01μf, ·002μf etc., etc. I can, thank heavens, still order them like this. I have just received from the USA some circuit modifications to cinema equipment we service—the components (nice squiggles for resistors!) are clearly marked ·1uf, ·01uf, 1·5k etc.

I have just looked at a Japanese circuit diagram—again the components are clearly labelled as above. You really think that it is easier to write 470n than ·47μf?? And 3K9 than 3·9K. I know which I prefer and which is easier to read. Who on earth wants to deal in nanofarads—I suspect that most service engineers like me will find the rigmarole of working these out an unnecessary chore.

You state that pointless values are less prone to printing or drawing errors—I would think you have no proof of this. Printing or drawing errors are only avoided by care in preparation and copy reading—making something easier to write does not necessarily make mistakes less easy to make.

How about an editorial rethink in the nice fresh air of Poole and a return to common sense?

P. Taylor,
St. Agnes,
Cornwall.

Maybe it is not easier to write 470n than ·47μF but remember we have to put 0·47μF to help avoid confusion, and how about 0·002μF or 2,000pF rather than 2n; such long designations can also be a problem on a crowded circuit diagram.

Unfortunately, a point is easily lost in printing or a dot may appear in just the wrong place. No amount of checking or proof reading will overcome this.

We are sure you will find 3k9 just as easy to read once you are used to it and nF is a perfectly valid denomination of F—writing 470n as opposed to 0·47uF is the same as writing 1mV instead of 0·001V—it is only a question of familiarity.

Any more views?—Editor.

All Change!

Sir—In your January editorial you justify your "pointless" component values as "it is widely accepted", while although you have no immediate plans to use boxes to represent resistors and capacitors, Toby Bailey expresses the view in his "letters" reply that such a move would be change for change sake, while you believe such a change would make circuits less easy to read.

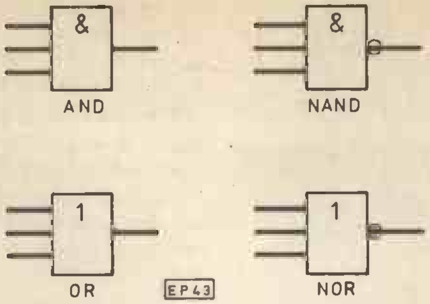
In principle I agree but then must ask, why you have departed from using the widely accepted symbols for logic gates that almost everybody (Mullard, SGS, Harris, Texas etc.) use.

Please practice what you preach and use easy to read symbols that are in common use and let's not have change for change sake! I don't care if your new symbols are in accordance with the "BS". BS will have to follow American practice in the end, it's happened before.

While I am writing may I ask your "Patents Reviewer" how Indesit of Turin got a patent (BP 1497418), January issue, on a technique that is common knowledge. I have read a number of articles on this topic over the years including one in the February 12th 1976 issue of "Electron" (pages 52-4) and I have known of the technique for at least 15 years.

B.H. Beeston
Enfield

We must point out that we have not "departed from using widely accepted symbols" or made "change for change sake". In fact our logic symbols have been used in P.E. since January 1972. There may now be a case for change and we have noted your feelings. By the way, we are not using BS gate symbols, some new BS symbols are:



Your point on the Indesit patent is taken up below.

Standard Patented

Sir— I am both dismayed and worried by the report, on page 68 of your January 1979 issue, that Indesit have been granted a British Patent on what has been the standard method of producing a log law potentiometer for several decades. I can remember being taught this method over twenty years ago as an apprentice and whenever I have needed a log law pot have used this method.

How then can a foreign washing machine maker claim to have invented such a technique? Does this mean that the British Patent Office is about to grant patents to foreign tea cup makers for the "new" method of obtaining a lower value resistor of non-preferred value, by putting another suitable resistor in parallel with the first one?

Perhaps some enterprising British company should apply for foreign patents on all the standard methods used in our industry to produce components of different values or characteristics from those readily available.

D. Lands,
Dorset.

May we assure readers that a patent has been granted to Indesit as described in the January issue. Our contributor, Adrian Hope, bases the reviews on copies of patents obtained from the Patent Office. Sometimes he deliberately selects patents on apparently old ideas to draw attention to such anomolies. So how do these anomolies arise and what can be done about them? The Department of Trade Press Office inform us that a search of existing literature is made before new patents are granted. But no search can ever be conclusive and it is for this very reason that patents can be challenged. Under the laws previously existing in the UK this has been a rather tortuous procedure. However a new law came into force in June 1978 which streamlines procedures (see next month's Patents Review). But due to the inherent slowness of patenting, patents will continue to be granted under the old laws for a period of several years yet. Although these are still open to "revocation" under transitional legal provisions, readers will in most cases be well advised to let sleeping dogs lie and simply ignore obviously invalid patents granted under the old laws. In any case readers should bear in mind that it is only public knowledge prior to the original filing date of a patent that invalidates it. The published reference given by Mr. Beeston was after the original filing date of the Indesit patent—January 1975.

Editor

DUAL PURPOSE LIGHTS REMINDER FOR CARS
REMINDS YOU TO TURN YOUR LIGHTS ON
REMINDS YOU TO TURN YOUR LIGHTS OFF

FOR all those motorists who like me, have a wife with a predilection for leaving the car lights on whenever possible, this unit should prove useful, for it will also give a warning of failing daylight thus performing a dual function, that is, it will give a warning when it is time to switch on the car lights, and also when the lights have been left on after the ignition has been switched off. This is particularly useful when the lights have been used during the day in times of poor visibility.

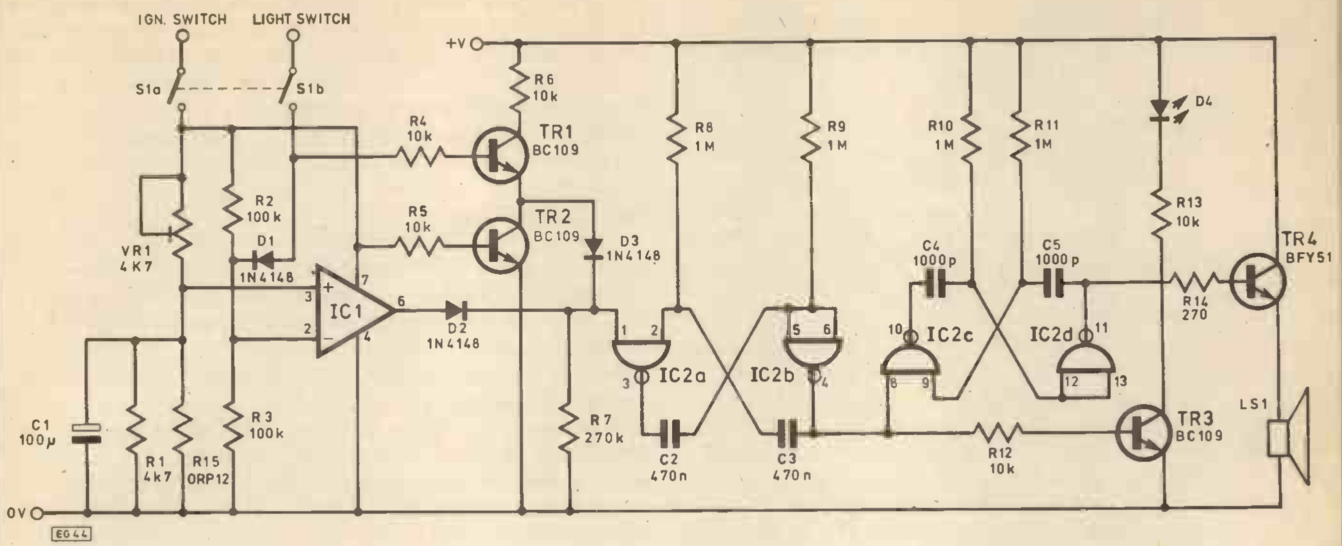
CIRCUIT DESCRIPTION

Perhaps the easiest way to explain the circuit operation is to split the circuit in two, that part before D3 performs the monitoring whilst all the circuitry after D3 gives the warning. As this is the simplest part of the circuit we shall deal with this first. Nand gates IC2a and b together with C2, C3, R8 and R9 are designed to oscillate at about 1Hz and can be enabled by applying a "high" input to pin 1. The output of this low frequency oscillator switches on and off transistor TR3 and so flashes a l.e.d. mounted on the dashboard of the car. R13 serves to limit current through the l.e.d. in the usual manner. At the same time the output of IC2b also enables a second oscillator comprising IC2c and d, C4 and C5 which operates at audio frequency. This output is amplified by TR4 and the warning is given by LS1, which can be a surplus

COMPONENTS . . .

Resistors	
R1	4k7
R2, R3	100k (2 off)
R4–R6, R12, R13	10k (5 off)
R7	270k
R8–R11	1M (4 off)
R14	270
R15	ORP 12 (l.d.r.)
Potentiometers	
VR1	4k7 preset
Capacitors	
C1	100µ
C2, C3	470n (2 off)
C4, C5	1000p ceramic (2 off)
Transistors and Diodes	
TR1–TR3	BC109 (3 off)
TR4	BFY51
D1–D3	1N4148 (3 off)
D4	TIL209
Integrated Circuits	
IC1	741
IC2	4011
Miscellaneous	
S1	d.p.s.t. switch
LS1	Telephone earpiece (or loudspeaker)
Printed circuit board	

Fig. 1. Full circuit diagram



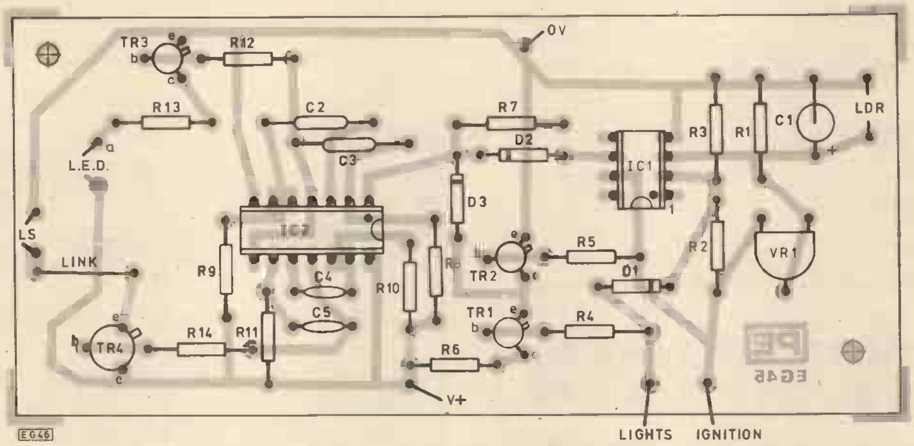


Fig. 2. Component overlay

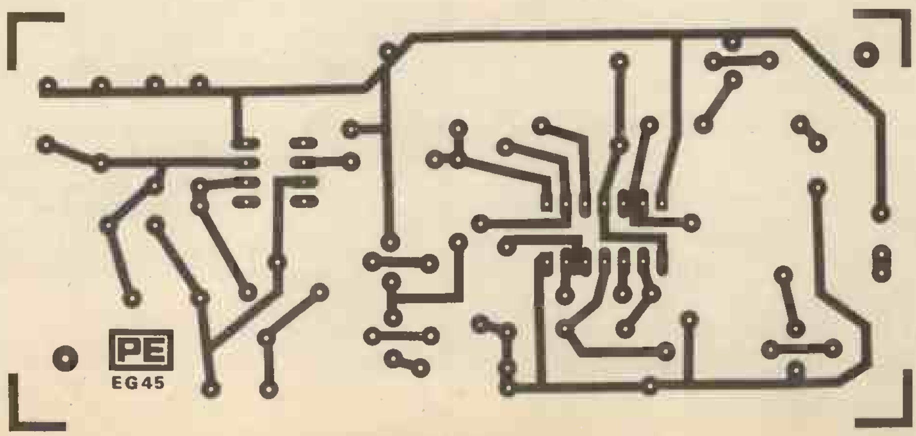


Fig. 3. Printed circuit

telephone earpiece. This part of the circuit is connected permanently to the car supply as it is necessary to give a warning when the ignition is switched off. This will not affect the car battery as the quiescent current consumption of the CMOS device is virtually zero. The only point of care here is that the outputs are taken from pins 4 and 11, as of course the outputs on pins 3 and 10 are high in the quiescent condition, and the alarm would operate.

MONITOR CIRCUIT

Now coming to the monitoring section of the circuit, the level of daylight is monitored by the light dependent resistor R15. As the level of daylight falls, so the resistance of the l.d.r. increases until it exceeds the level set by VR1. This potential is applied to the non-inverting input of IC1 pin 3. The potential at the inverting input of IC1 is held at half supply voltage by the potential divider R2-R3, when the non-inverting input exceeds this level by a few millivolts, the output at pin 6 will swing high due to the large open loop gain of IC1. This output is applied via D2 to pin 1 of IC2a to trigger the warning device. If the lights are now switched on, this would apply full battery voltage via D1 to the inverting input of IC1 and thus bring the output at pin 6 low again, turning off the warning. It will be noticed that this part of the circuit is fed via the ignition switch, and so will only give a warning of low light level when the ignition is switched on. However, if the ignition is switched off when the lights are switched on, this would turn transistor TR1 hard on, and because the ignition is switched off transistor TR2 would be turned hard off, thus the potential at the emitter of TR1 would be applied via D3 to the gate IC2a and so trigger the alarm circuit again. When the lights are now turned off TR1 would then be turned off and so pin 1 of IC2a would be returned to a low condition by R7 and the alarm would be disabled. The resistor R1 is included in parallel with the l.d.r. to prevent its resistance rising significantly above the maximum setting of VR1, C1 prevents spurious light changes affecting the circuit by providing a time constant of one or two seconds.

CONSTRUCTION

All the components are easily obtained and are fairly cheap; the usual precautions should of course be taken when handling the CMOS device, and for those readers who, like myself, actually enjoy etching their own circuit boards, a p.c.b. layout is provided. Incidentally if it is desired to use a small loudspeaker instead of a telephone earpiece, then the link shown on the p.c.b. layout may be removed and a suitable resistor inserted in place of this. The value would depend on the impedance of the loudspeaker, but 470 ohms should be about right for an 8 ohm speaker.

INSTALLATION

The switch S1a-b may be omitted, but would prove useful for disabling the alarm system in certain circumstances, such as when the lights are required to be left on for night parking. As mentioned previously the l.e.d. may be mounted in a prominent position on the dashboard, and LS1 concealed behind it. However, the l.d.r. is best mounted as near to the windscreen as possible.

The prototype unit was not mounted in any form of box, but was fastened to the rear of a convenient insulated panel with double sided servo tape, which can be obtained from most model shops. The best size is about 13mm wide ($\frac{1}{2}$in.) and 3mm ($\frac{1}{8}$in.) thick, and is ideal for mounting small p.c.b.s. However, if this method is used, precaution should be taken to ensure that none of the tracks on the p.c.b. can make contact with any metal surface.

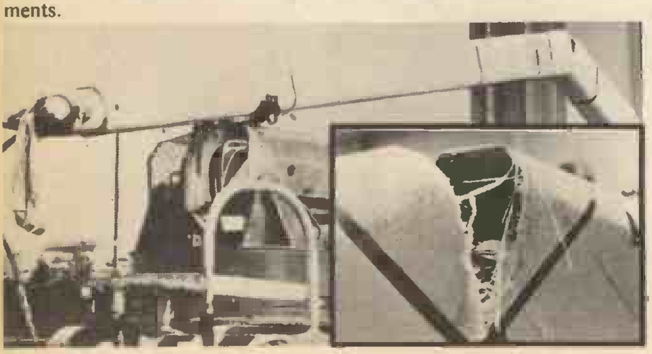
The trigger level may best be set by waiting until daylight has fallen to a level where it is necessary to switch on the lights, VR1 can then be adjusted until the unit just begins to operate. ★

News Briefs

CHERRY-PICKER BOOM BOON

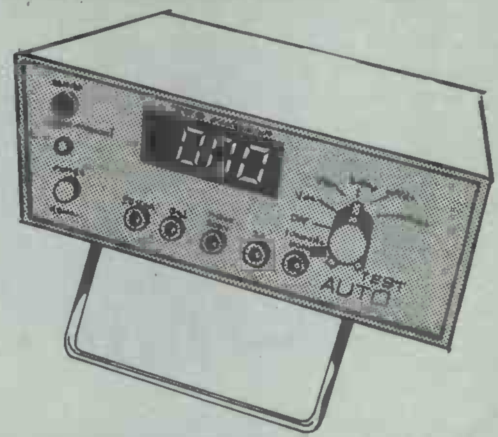
ACOUSTIC emission techniques have afforded the Georgia Power Company an early warning of failure in the booms of their overhead maintenance trucks (nicknamed cherry-pickers).

The sophisticated acoustic emission system supplied by Dunegan Endevco Ltd. listens to the high frequency "cries for help" of the material under stress, and by using this technique to determine the useful life of the booms, Georgia Power estimates that it has saved thousands of dollars in unnecessary "play it safe" scheduled replacements.



NEXT MONTH

Autoranging MULTIMETER



Full five function capability autoranging instrument that measures accurately a.c. and d.c. voltages, current and resistance.

BUBBLE MEMORIES

With non-volatile bubble memories no longer a lab' curiosity, it's time to learn just how they work. Next month's article by Dr. P. V. Cooper of Plessey Microsystems is your chance!

Also... PHASER

With six phase shift networks this offers improvements in this most popular of guitarist's sound effects.

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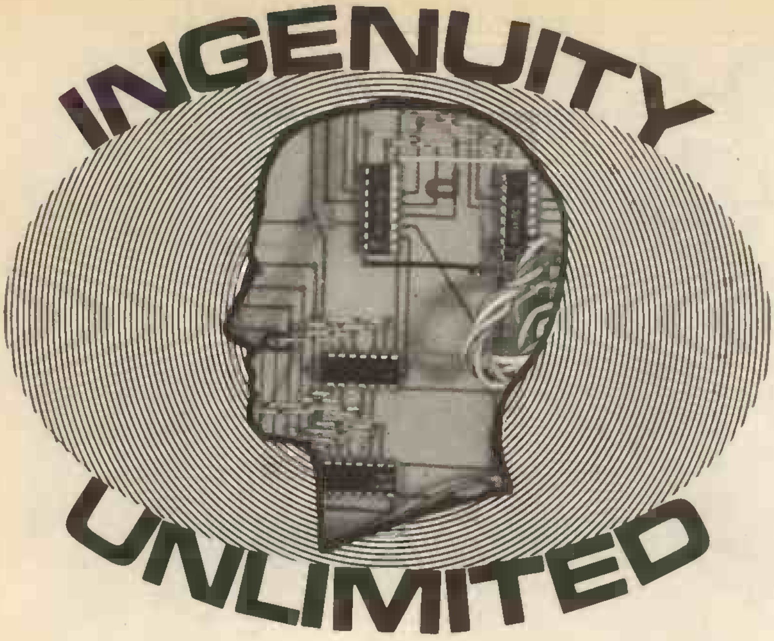
PRACTICAL
ELECTRONICS

OUR APRIL ISSUE WILL BE ON SALE FRIDAY, 9 MARCH 1979



A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

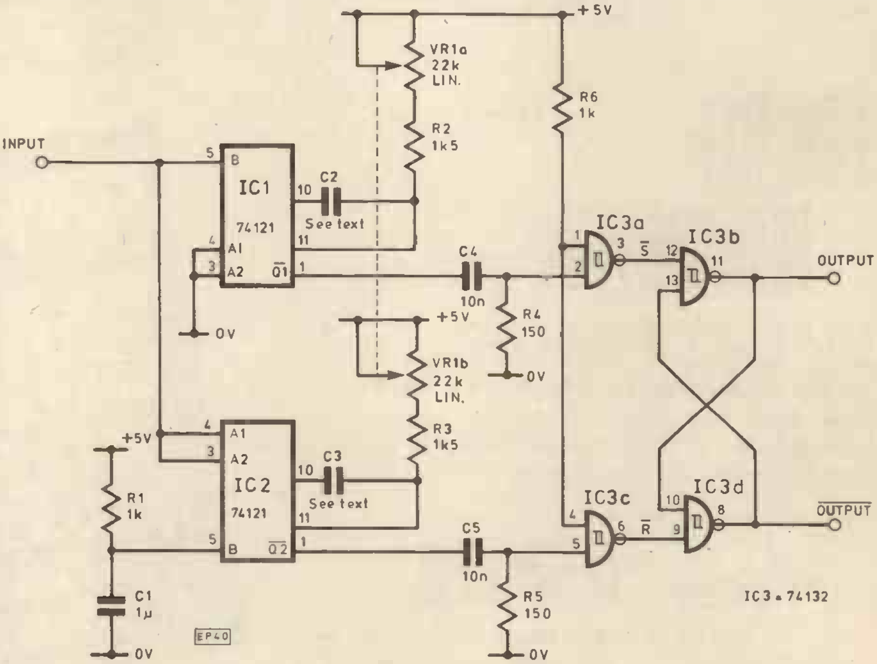
VARIABLE PULSE DELAY

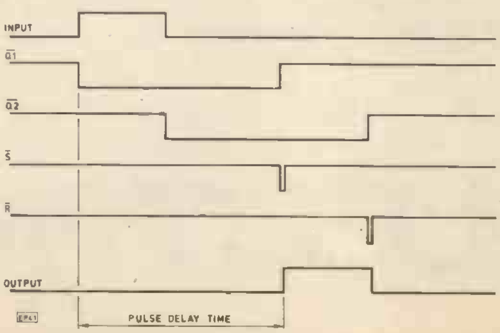
THIS circuit delays a TTL pulse by a variable time, without altering the length of the pulse. It was originally developed to delay trigger pulses between keyboard and ADSR in a synthesiser, to produce "repeat" and "double-tracking" effects, etc.; although other uses are possible.

Monostable IC1 is triggered by the positive-going edge of the input waveform, and IC2 is triggered by the negative edge. The pulse lengths are identical, and controlled by the ganged potentiometer VR1a/b. The outputs are differentiated and the short pulses applied to an RS flip-flop IC3a/d. This is alternately set and reset, so the output appears as a delayed version of the input. Note that further input pulses will be ignored until the first pulse is output; also that an inverted output is available. Network R1/C1 ensures that IC2 is triggered when the power is applied, so that the flip-flop is reset on switch-on.

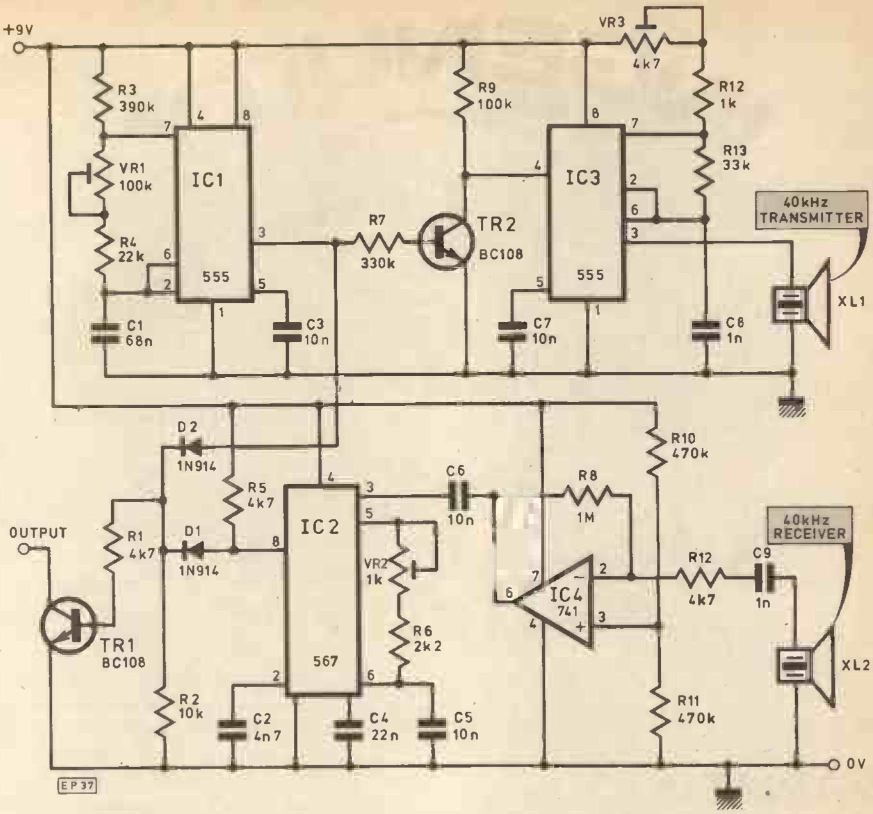
The circuit can provide delays from 5μS to 30S, depending on the value of C2 and C3; the accuracy of the output pulse depends mainly on the matching of C2/C3. In the prototype, C2 and C3 were 1μ, 10μ and 100μ (tantalum), switch selected, allowing delays from 1mS to 2S.

T. P. Hopkins,
Haywards Heath,
West Sussex.





ULTRASONIC PROXIMITY DETECTOR



THIS circuit consists of an ultrasonic transmitter and receiver in the same unit and relies on the reflection of the signal to detect the presence of a nearby object. As such, it may be used for burglar alarms, industrial batch counters or to prevent collisions in an electronic robot.

The transmitter consists of a 40kHz oscillator modulated by a second oscillator to provide a series of ultrasonic bleeps from the transducer. The oscillator does not self-stabilise to 40kHz, so VR3 is provided to adjust this frequency.

The received signal is amplified by IC4, and fed to IC2, an NE567 tone decoder. This responds only to signals of 40kHz—adjusted by VR2—having a small bandwidth. The output of this and the output of IC1 are combined, and fed to TR1.

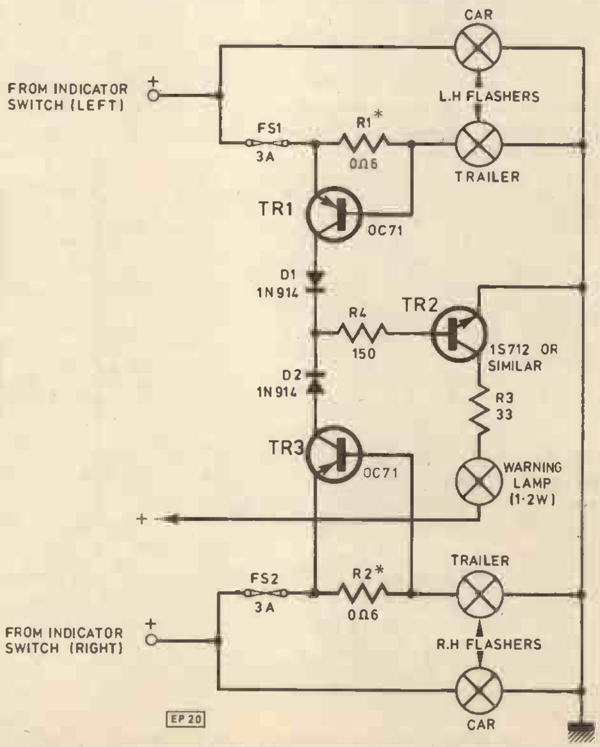
Thus, if an echo is heard by the receiver during a signal bleep from the transmitter, TR1 is turned off momentarily. This transistor has been left open collector in the circuit diagram, and users should connect this to suit their own requirements.

VR1 controls the duty cycle of IC1, and should be adjusted to set the maximum distance at which the circuit will respond. The supply voltage range is 5V to 9V, and current eonsumption is around 40mA. Although not shown on the diagram, supply decoupling capacitors should be included, particularly around the NE567 which is rather sensitive to supply noise. For this reason, attention should be paid to avoiding earth loops.

40kHz transducers are used since the higher ultrasonic frequencies are more directional. However, it is important to ensure that there is no direct sound path between the transmitter and receiver—cotton wool or fibre glass wadding are useful here.

D. F. Akerman,
Coventry.

TRAILER HAZARD FLASHER MONITOR



MY car was fitted as standard with a 42/84W flasher unit in order to operate the hazard warning system but had no provision for the extra warning light required by law when towing a trailer and, in my case, owing to a preformed cable loom, fitting another type would have been tricky.

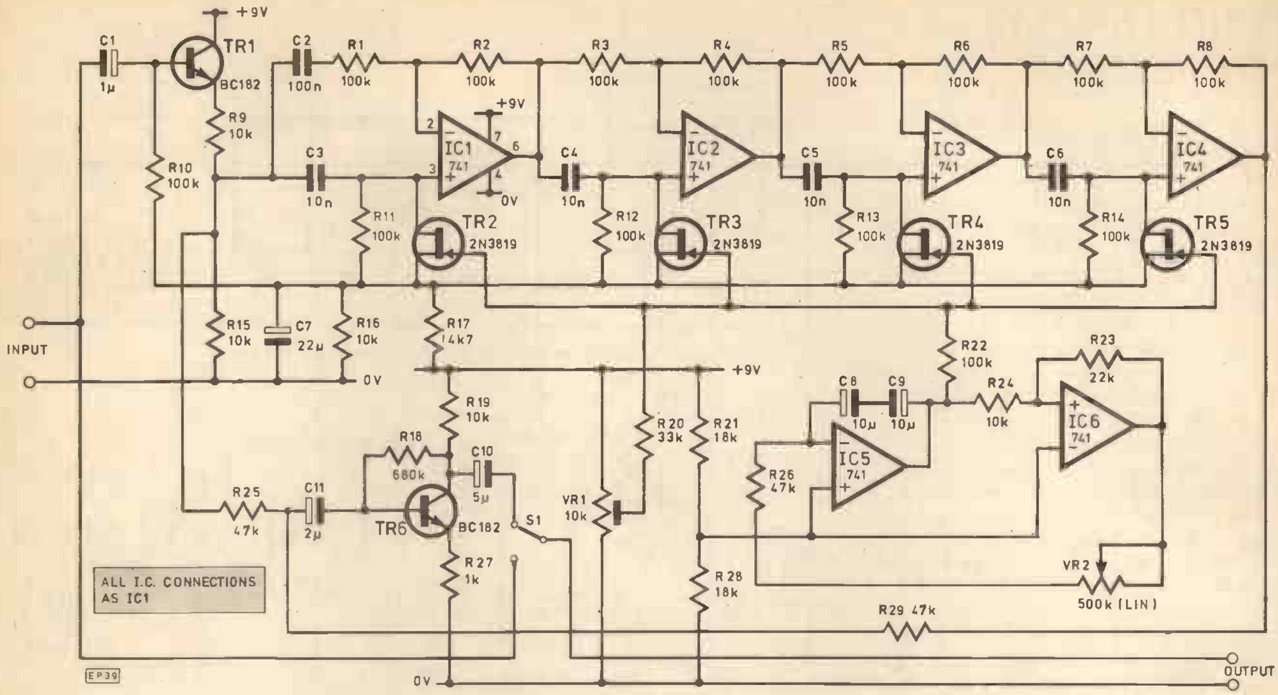
The circuit shown can be made in a couple of hours from common components and simply mounted in the boot of the car. The 1·2W lamp monitor indicates the operation of the trailer indicators and should be mounted at the dashboard.

The 0·6 ohm resistors (R1, R2) are small lengths of electric fire spiral filament. R3 prevents excessive current through TR3 at switch on due to low lamp filament resistance.

Note that this design is for negative earth vehicles only.

J. B. Farmer,
Melton Mowbray,
Leics.

SIMPLE PHASER



CIRCUITS for phasers are occasionally described in various magazines, but they inevitably have disadvantages; either they use difficult to obtain or expensive components, or they are so complex that they cannot be easily miniaturised. This circuit uses inexpensive, readily available components, can be simply constructed on Veroboard, and will fit in a die-cast box approximately $4\frac{1}{2} \times 2\frac{1}{2} \times 1\frac{1}{4}$ inches.

The input signal is applied to an emitter follower buffer, and then to four phase-shifting stages controlled by *n*-channel f.e.t.s (2N3189s or similar). This gives two notches in the frequency response; more (or less) stages could be used if desired.

The phase-shifted signal is mixed with the original to obtain the phasing effect, and amplified to the output. A switch is provided to disconnect the phaser when not required.

A variable speed triangle wave generator produces the sweep.

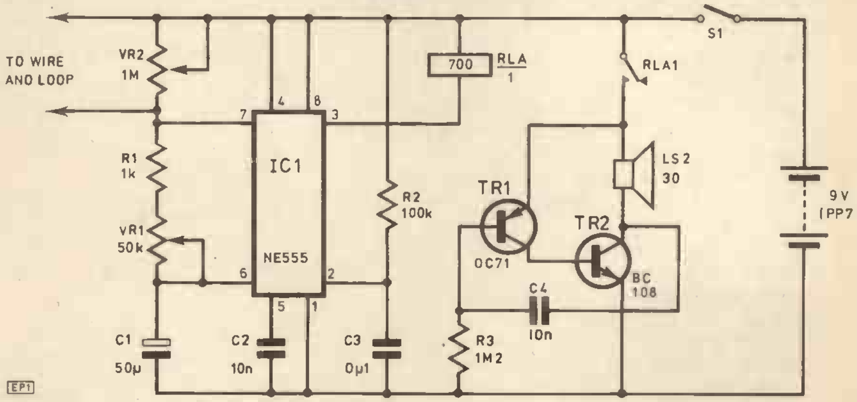
Power is provided by a small 9 volt battery (PP3). In use, VR1 is adjusted to give the best sound (a continuous "whooshing") with a white noise or music source.

The components used are not critical, although tantalum bead capacitors are preferred to save space, and other *n.p.n.* silicon transistors and *n*-channel FETs may be used.

The i.c.s are all 741 discrete types but they may be replaced by dual or quad types (e.g. SN72747N, MC3403P) to aid miniaturisation.

T.P. Hopkins,
Haywards Heath,
West Sussex.

LIVE-WIRE



THE 'Live-Wire' is a test of manual dexterity in which a player tries to move a wire ring along a thick metal wire, bent into awkward shapes, without touching the ring onto the wire. The wire and loop are normally simply connected to a battery and bell, but this circuit adds two refinements. The player has a time limit set by VR2 (between 16 and 94 seconds in the prototype), after which the alarm goes off and there is a sensitivity control.

With the sensitivity at maximum (VR1 at minimum resistance) a brief touch of the loop onto the wire will trigger the alarm, at minimum about 4 seconds touching is needed to trigger it.

When the apparatus is switched on the timing capacitor C1 begins charging and when it reaches about $2/3V_{cc}$ it triggers the NE555, connecting the supply voltage to the load and discharging. VR2 controls the normal charging rate of the capacitor and VR1 controls the rate at which it charges while the loop is in contact with the wire.

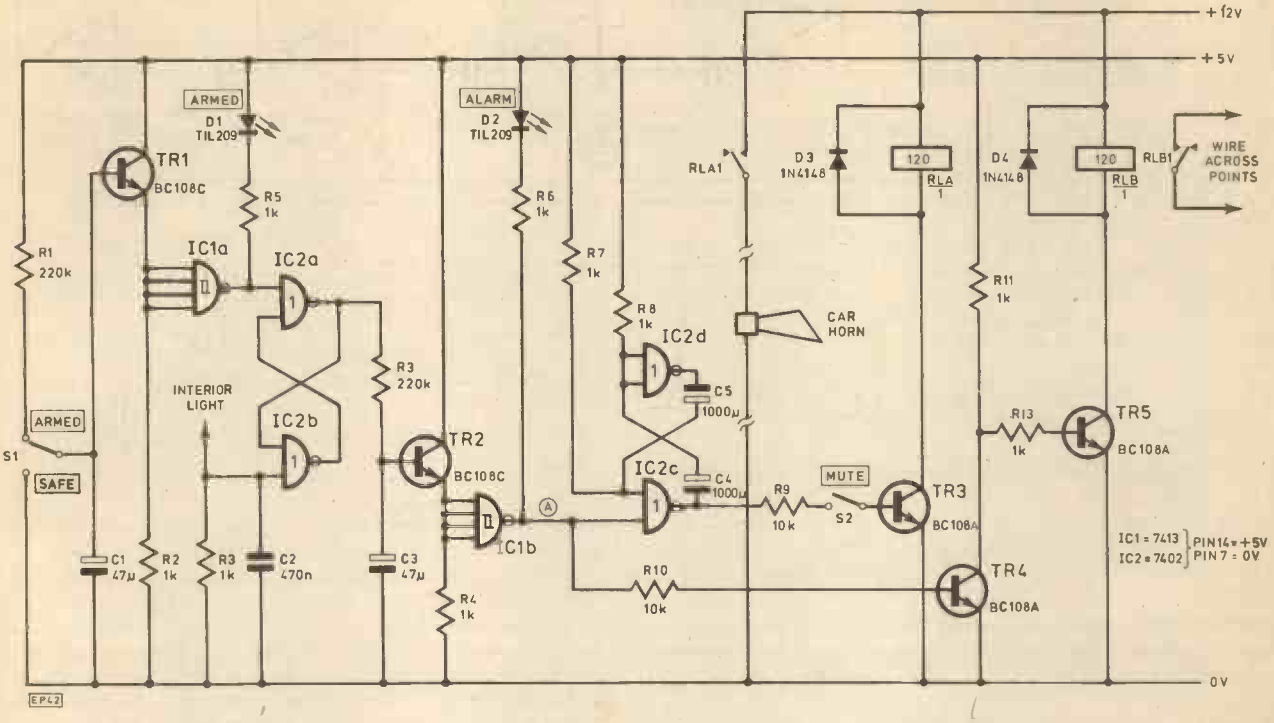
The alarm is reset by switching the apparatus off and then on again, applying a negative pulse to pin 2.

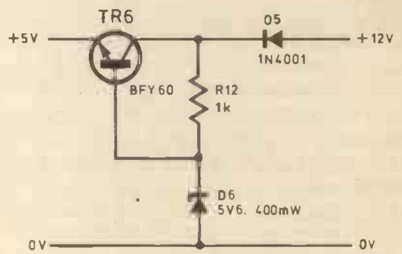
R3 in the oscillator is a rather high value so as to give the alarm a low, loud sound with low current consumption.

The oscillator could be replaced with a conventional bell or buzzer but the drain on the battery would be higher.

The only critical component is C1, which should have a low leakage. A tantalum capacitor would probably be best, but a miniature electrolytic works well in the prototype.

S. Kelly,
Chilwell,
Nottingham.





CAR INTRUDER ALARM

THIS circuit was devised as a simple car alarm which did not require an external de-sense switch. The circuit consists of two parts, the sensor and timer and the relay drivers.

The circuit operates as follows. When S1 is put into the armed position, C1 begins to charge via R1. This produces a slowly rising potential at the emitter of TR1 until after about 5 seconds the Schmitt's output goes low, and hence the reset input of the latch formed by part of IC2 also goes low, so that the output of the latch will go high as soon as the set input in made positive.

When the would-be intruder opens the door, he has set the latch by making the non earthy end of the interior light go positive. The latch will not reset until the hidden arm switch is restored to the safe position. When the output of the latch has gone positive, C3 is charged via R3 until the output of the second Schmitt avalanches from high to low. If, however, the hidden switch is put into the safe position, which will reset the latch, C3 will discharge. D1 is lit when the output of the first Schmitt is low, and the latch is not being continuously reset. C2 prevents spontaneous triggering by noise on the line, and R3 holds the set input of the latch to low if the bulb is blown or if the interior light is switched off (D1 is green, D2 red).

When the second Schmitt goes low, the alarm l.e.d. (D2) lights and the oscillator using the remaining part of the 7402 starts oscillating at about 1·4Hz. The frequency could be much lower than this due to the tolerance of the electrolytic capacitors (C4 and C5). Should the mute switch be closed, the coil of RLA1 will energise and de-energise at this frequency, sounding the horn. When point A goes low, apart from enabling the oscillator, it turns off TR4 pushing the base of TR5 positive through R11 and R13. This switches on TR5 and energises the coil of RLA2, the contacts of which short out the points so immobilising the car. D3 and D4 are to protect the transistors from the transients caused by the relay coils.

Included is a simple series regulator circuit which could be used to obtain 5 volts for the TTL i.c.s. Note the inclusion of D5; this is to prevent reverse polarity voltage causing damage to the circuit.

N. J. Bailey,
Yatton,
Bristol.

News Briefs

by Mike Abbott

MICRO' COURSES

TWO TRAINING courses, approved by the Department of Industry under the Microprocessor Application project scheme, are being run by Bleasdale Computer Systems Ltd. Course attendees will receive a contribution of £50·00 from the Department of Industry towards the cost of the course fee.

The Bleasdale courses *Introduction to Microprocessors* and *Designing Systems with Microprocessors* are intended to give the course attendees a good understanding of the aspects of designing and building microprocessor based systems. To achieve this, Bleasdale has designed and developed a range of microprocessor Input/Output units for use on the course.

The schedule for the 1 week *Introduction to the 6800* and the advanced 2 week course *Designing Systems with the 6800* for 1979 is:

Introduction to the 6800	Designing Systems with the 6800
5th Mar 79— 9th Mar 79	12th Mar 79—23rd Mar 79
7th May 79—11th May 79	14th May 79—25th May 79
3rd Sept 79— 7th Sept 79	10th Sept 79—21st Sept 79
12th Nov 79—16th Nov 79	19th Nov 79—30th Nov 79

For further details contact: June Dove, Course Registrar, Bleasdale Computer Systems Ltd., 7 Church Path, Merton Park, London SW19. Tel: 01-540 8611.

TAKE OVER

A TAKE OVER of Hacker, manufacturers of portable radios and music centres, has brought about the move of Hacker production from Maidenhead to Motoradio's modern plant at Bournemouth, where a fully equipped after sales and service department is also being established.

BUBBLE TAKE OVER

NOW available on an off-the-shelf basis from Texas Instruments, is the Model 765 portable bubble-memory terminal which offers a unique method of data entry, editing and storage for commercial applications such as remote sales-order entry, computer time-sharing systems and newspaper reporting. Because the terminal's bubble memory retains data even when the power is switched off, information from a variety of sources can be stored in the terminal for as long as required, and then transmitted in a single batch over a normal telephone line using the built-in acoustic coupler.

Unlike other methods of data storage the Model 765's bubble memory has no moving parts, and requires no external storage media. In addition, it has specifically been designed for ease of use in the normal business environment, with a standard typewriter-like keyboard and simple English-language commands.

Using TI's Silent 700 thermal-printer technique, the Model 765 is a full-capability 30-characters-per-second terminal with a full ASCII keyboard, a powerful command mode, and a file management system.

Prompting and operator lead-through routines can easily be developed to allow fast and efficient data entry, and the built-in editing facility allows on-the-spot correction of data. The terminal transmits data at 300 baud using the acoustic coupler, or at up to 9600 baud using an RS-232 serial EIA interface.

Further information from Texas Instruments Ltd., Digital Systems Division, Manton Lane, Bedford, MK41 7PA.

POWER SUPPLY BREAKER

WITH essential data being held and processed these days, by electronic equipment working around the clock, it is vital to know the degree of immunity a machine has to mains power interruption.

Any engineer who has had the task of ensuring that a system meets the specification laid down in this respect, will know the problems when it comes to generating a programme of known interruptions in the mains power, without purpose-built equipment to do this.

What is described as invaluable in the study and solving of interference problems, is the NS251 unit from Seltek Instruments Ltd. of Stanstead Abbotts, Herts. Measuring 430 × 88 × 360mm, the NS251 will simulate breakdowns on a.c. and d.c. power lines. Pre-selection of the breakdown period is completely independent of the phase of the power line voltage. Breakdown time is fully adjustable from 1ms to 1,000ms. Both positive and negative trigger can be selected. Triggering is effected by a manual front panel knob, or may be activated automatically by an external signal. Two monitor outputs are available for measurement purposes when using an oscilloscope.

The effective voltage range of the NS251 is 0 to 250V a.c./d.c. with current to 4A (peak current 40A at 10ms max.). The unit is switched in series with the power line and the test object or system. Phase range covers the full 180° and extreme values (90°, 180°) can be adjusted. Breakdowns for both the positive and negative half cycles are separate and selectable.

VIDEO LIBRARY

GOING to the pictures today seems synonymous with the long drive to find a cinema that hasn't been converted to a bingo hall, battling through the traffic to a rip-off car park, the long open air queue outside a multi-studio cinema that's been showing the same films for months on end, and the "full up" sign. It is with relief that most of us will witness the first signs of an alternative to this expensive agony. The chance to watch a feature film with one's feet up in the comfort of one's own home (perhaps with a few friends), starting when you like, with an interval when you like, and whatever *inexpensive* refreshments you may fancy.

For the first time in the UK, the growing number of video cassette recorder owners (now estimated to number 25,000), are being offered a comprehensive software library. Intervision Video now offer over 200 full length feature films, including such titles as *Blow out*, *Sunday In The Country*, and *The Happy Hooker* as well as films of *Chess Masterclass*, *Angling*, *Music* and other light entertainment.

The service Intervision has launched offers the home video consumer the opportunity to obtain tapes from either the Intervision Video Club (basically a mail-order or personal collection service operating from the company's new headquarters), or through selected dealers throughout the country who hold copies of Intervision programme cassettes.

Copies are available on all of the popular home video cassette formats, and Intervision have their own in-house videocassette duplicating facilities, which are claimed the most sophisticated in the country.

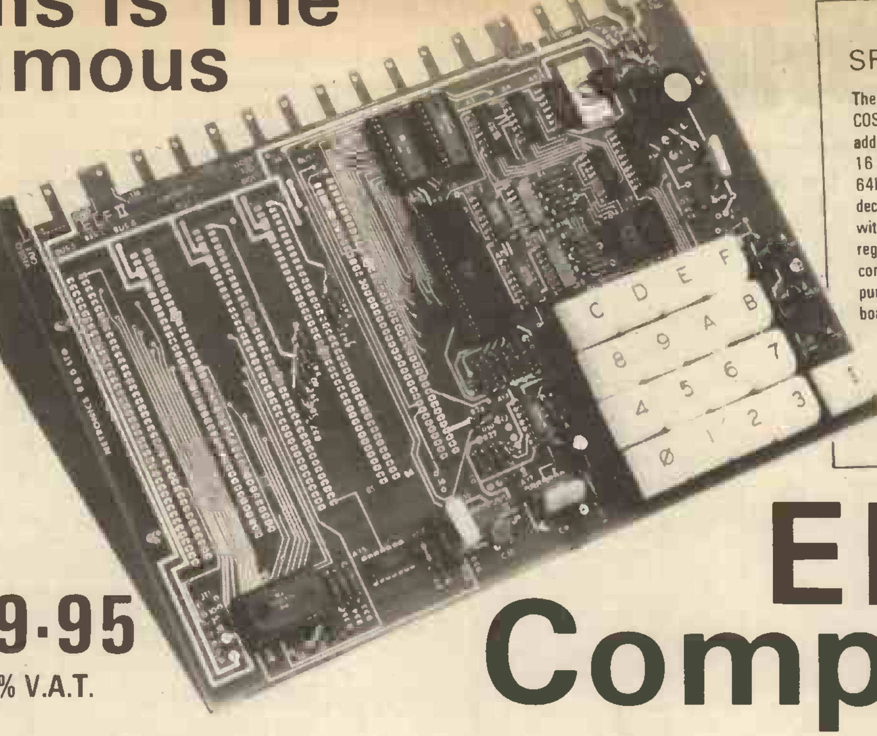
Despite the very high investment cost embracing both the equipment and the acquisition of the legal copyrights, the joint Managing Directors, Richard Cooper and Michael Tenner, are very confident that the service is going to be successful. Response so far has been described as "phenomenal."

Hiring a programme on a one-cassette format such as VCR-LP, BETAMAX, or VHS costs only £5·95 *including* VAT for a two day hire period. Intervision have not lost sight of the hotel, disco and club market, where a hire charge of £15·95 enables a programme to be shown to a large nonpaying audience. The company's range of music programmes featuring such top names as *Roberta Flack*, *Neil Sedaka*, and *Donna Summer* are much in demand from 'discoland'.

Video cassette recorders are not cheap, although significant price avalanches are forecast, but already it would be feasible to club together with a group of friends for film evenings. Perhaps the day will come when new films are like new books and go straight into shops and libraries, making drunk-dodging on the way home from the cinema a thing of the past!

More details from Intervision Video Ltd, 102 Holland Park Ave, London, W11 4UA.

This Is The Famous



SPECIFICATIONS

The £99.95 ELF II computer features an RCA COSMAC COS/MOS 1802 8-bit microprocessor addressable to 64K bytes with DMA, interrupt, 16 registers, ALU, 256 byte RAM expandable to 64K bytes, professional hex keyboard fully decoded so there's no need to waste memory with keyboard scanning circuits, built-in power regulator, 5 slot plug-in expansion bus (less connectors), stable crystal clock for timing purposes and a double-sided, plated-through pc board plus RCA 1861 video IC to display any segment of memory on a video monitor or TV screen along with all the logic and support circuitry you need to learn every one of the RCA 1802's capabilities.

ELF II Computer

£99·95
PLUS 8% V.A.T.

Stop reading about computers and get your hands on one! With ELF II and our new *Short Course* by Tom Pittman, you can master computers in no time at all! ELF II demonstrates all 91 commands an RCA 1802 can execute and the *Short Course* quickly teaches you how to use each of the 1802's capabilities.

Elf II's video output lets you display an alphanumeric readout or graphics on any TV screen or video monitor and enjoy the latest video games.

But that's not all. Once you've mastered computer fundamentals, ELF II can give you POWER with add-ons that are among the most advanced found anywhere. American IEEE chapters plus hundreds of universities and major corporations have chosen the ELF II to introduce their students and personnel to microprocessor computing!

Learn The Skill That May Soon Be Far More Important Than Your College Degree!

The ability to use a computer may soon be more important to your earning power than a college degree. Without a knowledge of computers, you are always at the mercy of others when it comes to solving highly complex business, engineering, industrial and scientific problems. People who understand computers can command MONEY and to get in on the action, you must learn computers. Otherwise you'll be left behind.

ELF II Is The F-A-S-T Way to Learn Computer Fundamentals!

Regardless of how minimal your computer background is now, you can learn to programme a computer in almost no time at all. That's because Netronics has developed a special *Short Course on Microprocessor And Computer Programming* in non-technical language that leads you through every one of the RCA COSMAC 1802's capabilities so you'll understand *everything* ELF II can do. . . . *and how to get ELF II to do it!*

All 91 commands that an 1802 can execute are explained to you, step-by-step. The text, written for Netronics by Tom Pittman, is a tremendous advance over every other programming book in print.

Keyed specifically to the ELF II, it's loaded with "hands on" illustrations. When you're finished, ELF II and the 1802 will no longer hold any mysteries for you.

In fact, not only will you be able to use a personal computer creatively, you'll also be able to *understand* computing articles in the technical press.

If you work with large computers, ELF II and our *short Course* will help you to understand what makes them tick.

A Dynamite Package For Just £99.95 Plus 8% V.A.T.!

With ELF II, you learn to use machine language – the fundamental language of all computers. Higher level languages such as FORTRAN and BASIC must be translated into machine language before a computer can understand them. With ELF II you build a solid foundation in computers so you'll really know what you're doing, no matter how complicated things get.

Video output also makes ELF II unique among computers selling such a low price. Attached to your TV set, ELF II becomes a fabulous home entertainment centre. It's capable of providing endless hours of fun for both adults and children of all ages! ELF II can create graphics, alphanumeric displays and fantastic video games.

Only a low cost RF modulator is required to connect ELF II to your TV's aerial socket! (To order see below.)

ELF II's 5-card expansion bus (connectors not included) allows you to expand ELF II as your needs for power grows. If you're an engineer or hobbyist, you can also use ELF II as a counter, alarm, lock, thermostat, timer, or for countless other applications.

ELF II Explodes Into A Giant!

Thanks to ongoing work by RCA and Netronics, ELF II add-ons are among the most advanced anywhere. Plug in the **GIANT BOARD** and you can record and play back programmes, edit and debug programmes, communicate with remote devices and make things happen in the outside world. Add **Kluge Board** to get ELF II to solve special problems such as operating a more complex alarm system or controlling a printing press. Add 4k RAM board and you can write longer programmes, store more information and solve more sophisticated problems.

Expanded, ELF II is perfect for engineering, business, industrial, scientific and personal finance and tax applications. No other small computer anywhere near ELF II's low price is backed by such an extensive research and development programme.

The ELF-BUG Monitor is an extremely recent breakthrough that lets you debug programmes with lightening speed because the key to debugging is to know what's inside the registers of the microprocessor and, instead of single stepping through your programme, the ELF-BUG Monitor, utilising break points, lets you display the entire contents of the registers on your TV screen at any point in your programme. You find out immediately what's going on and can make any necessary changes. Programming is further simplified by displaying 24 bytes of RAM with full address, blinking cursor and auto scrolling. A must for serious programmers!

Netronics will soon be introducing the ELF II Colour Graphics & Music System – more breakthroughs that ELF II owners will be the first to enjoy!

Now BASIC Makes Programming ELF II Even Easier!

Like all computers, ELF II understands only "machine language" – the language computers use to talk to each other. But, to make life easier for you, we've developed an ELF II Tiny BASIC. It talks to ELF II in machine language for you so that you can programme ELF II with simple words that can be typed out on a keyboard such as PRINT, RUN and LOAD.

"Ask Not What Your Computer Can Do . . . But *What Can It Do For YOU!*"

Don't be trapped into buying a dinosaur simply because you can afford it and it's big. ELF II is more useful and more fun than "big name" computers that cost a lot more money.

With ELF II, you learn to write and run your own programmes. You're never reduced to being a mere keypunch operator, working blindly with someone else's predeveloped software.

No matter what your speciality is, owning a computer which you really know know how to use is sure to make you a leader. ELF II is the fastest way there is to get into computers. Order from the coupon below!

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☐ Deluxe metal cabinet with plexiglas dust cover for ELF II, £29·95* plus £1·50 p&p.

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☐ GIANT BOARD kit with cassette I/O, RS 232-C/TTY I/O, 8-bit P I/O, decoders for 14 separate I/O instructions and a system monitor/editor. £39·95* plus £1·00 p&p.

☐ Kluge (Prototype) Board accepts up to 36 IC's. £17·00 plus 50p. p&p.

☐ 4k Static RAM kit. Addressable to any 4k page to 64k. £89·95* plus 50p. p&p.

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☐ Professional ASCII Keyboard kit with 128 ASCII upper/lower case set, 96 printable characters, onboard regulator, parity, logic selection and choice of 4 handshaking signals to mate with almost any computer. £64·95* post paid.

☐ Deluxe metal cabinet for ASCII Keyboard. £19·95* plus £1·50 p&p.

☐ ELF II Tiny BASIC on cassette tape. Commands include SAVE, LOAD, ±, x, ÷, ( ), 26 variables A-Z, LET, IF/THEN, INPUT, PRINT, GO TO, GO SUB, RETURN, END, REM, CLEAR, LIST, RUN, PLOT, PEEK, POKE. Comes fully documented and includes alphanumeric generator required to display alphanumeric characters directly on your TV screen without additional hardware. Also plays tick-tack-toe plus a drawing game that uses ELF II's hex keyboard as a joystick, 4k memory required. £14·95* post paid.

☐ Tom Pittman's Short Course on Tiny BASIC for ELF II. £5·00* post paid.

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Yes! I want to run programmes at home and have enclosed: ☐ £109·56 including postage and V.A.T. for RCA COSMAC ELF II kit. ☐ £5·94 including postage and V.A.T. for power supply (required). ☐ £5·95 for RCA 1802 User's Manual. ☐ £5·95 including postage and V.A.T. for *Short Course on Microprocessor Computer Programming*.

☐ I want mine wired and tested with power supply, RCA 1802 User's Manual and *Short Course* included for just £164·10 including postage and V.A.T.

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A breadboard as big as your ideas.

EXPERIMENTOR 325 £2.54
The ideal Breadboard for 1 chip circuits. Accepts 8, 14, 16 and up to 22 pin IC's. Has 130 contact points including two 10-point bus-bars.

EXPERIMENTOR 650 £4.70
Perfect for checking out Microprocessors. EXP 650 has 270 contacts including two 20-point bus-bars with 0.6" centres.

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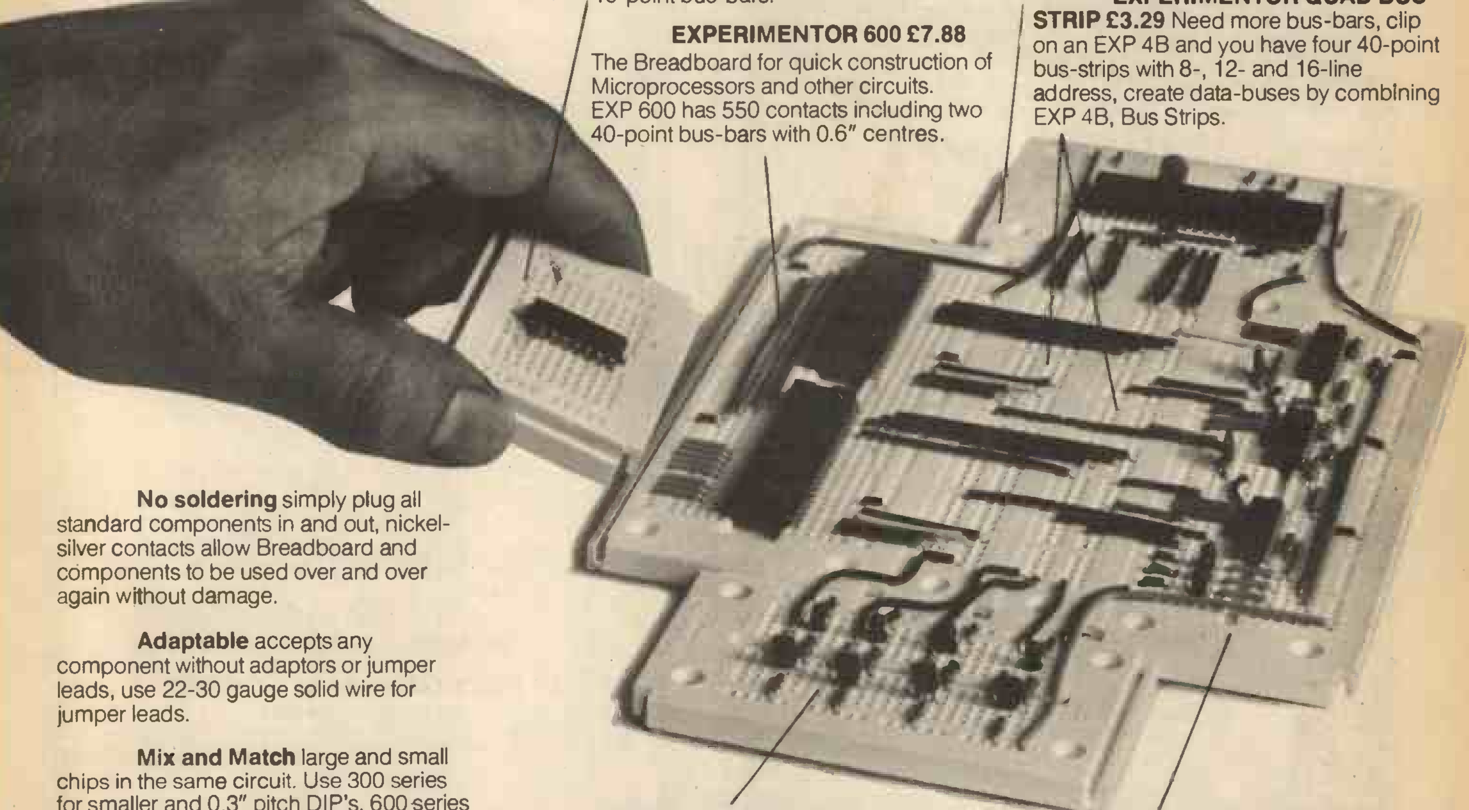
The Breadboard for quick construction of Microprocessors and other circuits. EXP 600 has 550 contacts including two 40-point bus-bars with 0.6" centres.

EXPERIMENTOR QUAD BUS STRIP £3.29 Need more bus-bars, clip on an EXP 4B and you have four 40-point bus-strips with 8-, 12- and 16-line address, create data-buses by combining EXP 4B, Bus Strips.



No soldering simply plug all standard components in and out, nickel-silver contacts allow Breadboard and components to be used over and over again without damage.

Adaptable accepts any component without adaptors or jumper leads, use 22-30 gauge solid wire for jumper leads.

Mix and Match large and small chips in the same circuit. Use 300 series for smaller and 0.3" pitch DIP's. 600 series for Microprocessors with 0.6" centre channel for full fan-out with larger chips.

Smallest to Biggest, remember CSC's Breadboards "snap-lock" together so you can start with a small idea and expand your ideas to as Big a Breadboarding area as you like.

Easy Permanent Mounting, using four screws from front or six self-tappers from rear. Vinyl-insulated backing lets you fasten to any surface.

EXPERIMENTOR 350 £4.21
EXP 350, specifically designed for the hobbyist working with up to 3 x 14 DIP IC's. With 270 contact points including two 20-point bus-bars the EXP 350 accepts any size DIP with 0.3" spacing.

Marked Contact Points transfer component by component from letter/number position on Breadboard to finished P.C. Board or Wiring Table.

Ruggedly built of abrasion-resistant materials that withstand 100°C.

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MODEL NO.	NUMBER OF CONTACT HOLES	IC CAPACITY (14-pin DIP's)	UNIT PRICE (includes Post & VAT)
EXP 300	550	6	£7.29
EXP 600	550	use with 0.6" PITCH DIP's	£7.88
EXP 350	270	3	£4.21
EXP 650	270	use with 0.6" PITCH DIP's	£4.70
EXP 325	130	1	£2.54
EXP 4B	FOUR 40-point Bus-Bars	—	£3.29

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Type	Voltage	Curent	£	p/p
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08FE06	6+6	0.6A EACH	1.80	50p
12FE06	6+6	1A EACH	2.00	60p
20FE06	6+6	1.6A EACH	2.60	70p
50FE06	6+6	3A EACH	3.10	70p
60FE06	6+6	4A EACH	3.60	85p
06FE09	9+9	0.3A EACH	1.50	50p
08FE09	9+9	0.5A EACH	1.80	50p
12FE09	9+9	0.75A EACH	2.00	60p
20FE09	9+9	1A EACH	2.60	70p
50FE09	9+9	2.5A EACH	3.10	70p
60FE09	9+9	3A EACH	3.60	85p
06FE12	12+12	0.25A EACH	1.50	50p
08FE12	12+12	0.3A EACH	1.80	50p
12FE12	12+12	0.5A EACH	2.00	60p
20FE12	12+12	0.8A EACH	2.60	70p
50FE12	12+12	2A EACH	3.10	70p
60FE12	12+12	2.5A EACH	3.60	85p
80FE12	12+12	3A EACH	4.50	100p
06FE15	15+15	0.2A EACH	1.50	50p
08FE15	15+15	0.25A EACH	1.80	50p
12FE15	15+15	0.4A EACH	2.00	60p
20FE15	15+15	0.6A EACH	2.60	70p
50FE15	15+15	1.6A EACH	3.10	70p
60FE15	15+15	2A EACH	3.60	85p
80FE15	15+15	3A EACH	4.50	100p
06FE20	20+20	0.15A EACH	1.50	50p
08FE20	20+20	0.2A EACH	1.80	50p
12FE20	20+20	0.25A EACH	2.00	60p
20FE20	20+20	0.5A EACH	2.60	70p
50FE20	20+20	1.2A EACH	3.10	70p
60FE20	20+20	1.5A EACH	3.60	85p
80FE20	20+20	2A EACH	4.50	100p
CHARGER TRANSFORMER				
48FE12	0-6-12	4A	3.10	70p
66FE12	0-6-12	5A	3.80	85p
70FE12	0-6-12	6A	4.86	100p
08FE24	24+24	0.15A EACH	1.80	50p
12FE24	24+24	0.2A EACH	2.00	60p

Type	Voltage	Current	£	p/p
20FE24	24+24	0.4A EACH	2.60	70p
50FE24	24+24	0.8A EACH	3.10	70p
60FE24	24+24	1.2A EACH	3.60	85p
80FE24	24+24	1.5A EACH	4.50	100p
50FE28	28+28	0.75A EACH	3.10	70p
60FE28	28+28	1.1A EACH	3.60	85p
80FE28	28+28	1.4A EACH	4.50	100p
20FE30	30+30	0.35A EACH	2.60	70p
50FE30	30+30	0.75A EACH	3.10	70p
60FE30	30+30	1A EACH	3.60	85p
80FE30	30+30	1.2A EACH	4.50	100p
MULTI-TAP RANGE, VOLTAGE AVAILABLE 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 12-0-12 OR 15.0-15				
30FE30	0-12-15 24-30	1A	3.40	70p
60FE36	0-12-15 24-30	2A	3.70	85p
80FE36	0-12-15 24-30	3A	4.50	100p
100FE40	0-12-15 24-30	4A	5.60	115p
CENTRE TAP SECONDARY				
FE06	6-0-6	1A EACH	2.00	60p
FE09	9-0-9	1A EACH	2.60	70p
FE12	12-0-12	1A EACH	2.60	70p
FE15	15-0-15	1A EACH	3.10	70p
FE20	20-0-20	1A EACH	3.10	70p
60FE52	26-0-26	1A EACH	3.60	100p
60FE28	28-0-28	1A EACH	3.60	100p
60FE60	30-0-30	1A EACH	3.60	100p
100FE26	26-0-26	2A EACH	5.15	115p
100FE30	30-0-30	2A EACH	5.15	115p
100FE36	36-0-36	2A EACH	5.15	115p
AIR CORED AUDIO CROSS OVER COILS				
FE01	0.1mH		0.26	20p
FE03	0.3mH		0.26	20p
FE05	0.5mH		0.30	20p
FE10	1.0mH		0.60	25p
FE26	2.0mH		0.75	30p

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W877 675R 12-27V DPCO 23x20x10mm sealed can **86p**
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W830 200R 6-12V DPCO 23 x 20 x 10mm sealed can **88p**
Send SAE for our relay list – 84 types listed and illustrated.

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Mono gen. purpose amp with tone and Vol/on-off controls. Utilizes sim. circuitry to above amp. Output 2W into 8 ohms. Input matched for crystal cartridge. 4 transistor circuit. Simple to build on PCB provided. Can be either battery or mains operated. (For mains powered version add £2·20 for suitable transformer.) Blue vinyl covered aluminium case to suit (W372) **£1·30**

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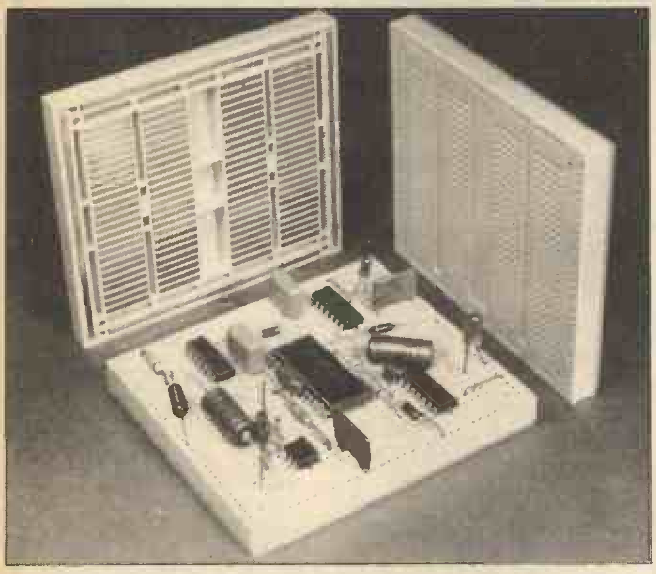

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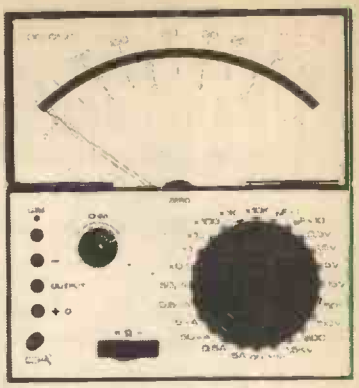

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AC125	0.17
AC126	0.17
AC127	0.16
AC127K	0.23
AC128	0.14
AC128K	0.25
AC128/176	0.42
AC142	0.18
AC153	0.55
AC158	0.50
AC176	0.16
AC187	0.50
AC187K	0.55
AC188K	0.55
ACY20	1.02
ACY22	1.02
AD142	0.87
AD143	0.87
AD149	0.65
AD161	0.35
AD161/162	0.70
AD162	0.35
AD262	0.36
AD263	0.36
ADY26	4.74
ADZ11	4.05
AF106	0.45
AF109R	0.36
AF124	0.25
AF125	0.25
AF126	0.25
AF127	0.25
AF139	0.32
AF178	0.30
AF179	0.30
AF200	0.36
AF201	0.39
ASY73	0.30
ASZ15	0.60
ASZ16	0.60
ASZ17	0.60
AU103	0.90
AU107	1.00
AU110	0.90
AU210	0.90
BC107	0.06
BC107A	0.07
BC107B	0.07
BC108	0.06

BC108A	0.07
BC108	0.07
BC109	0.06
BC109B	0.07
BC109C	0.07
BC113	0.12
BC114	0.15
BC116	0.13
BC117	0.15
BC118	0.12
BC119	0.25
BC125	0.15
BC125B	0.16
BC126	0.15
BC136	0.15
BC137	0.15
BC138	0.30
BC140	0.27
BC141	0.29
BC142	0.20
BC147	0.06
BC147B	0.07
BC148	0.06
BC148A	0.07
BC148B	0.07
BC149	0.06
BC157	0.06
BC157A	0.07
BC158	0.07
BC158A	0.08
BC158V1	0.09
BC159	0.06
BC159A	0.07
BC159B	0.07
BC161	0.25
BC167	0.06
BC168	0.06
BC169	0.06
BC170B	0.07
BC170C	0.07
BC171	0.06
BC171A	0.07
BC171B	0.07
B172	0.06
BC172A	0.07
BC172B	0.07
BC172C	0.07
BC173	0.06
BC173B	0.07
BC174B	0.07
BC177A	0.12

BC177B	0.12
BC178B	0.12
BC179	0.12
BC182A	0.09
BC182B	0.09
BC183A	0.09
BC183LA	0.09
BC183LB	0.10
BC184	0.08
BC184L	0.09
BC184LB	0.10
BC186	0.19
BC187	0.19
BC204	0.08
BC204B	0.09
BC206	0.10
BC206B	0.10
BC207	0.10
BC209B	0.09
BC212A	0.10
BC213L	0.10
BC214L	0.10
BC237	0.15
BC237A	0.16
BC237C	0.21
BC238	0.15
BC238B	0.16
BC238C	0.18
BC251A	0.15
BC251B	0.17
BC252A	0.15
BC252B	0.17
BC252C	0.20
BC258	0.20
BC261A	0.10
BC262	0.20
BC267A	0.21
BC267B	0.22
BC268	0.21
BC304	0.25
BC307	0.15
BC307A	0.15
BC307B	0.15
BC308	0.15
BC309A	0.15
BC317B	0.15
BC322	0.10
BC327	0.16
BC328	0.16
BC337	0.16
8C338	0.16

BC348A	0.15
BC350A	0.17
BC441	0.20
BC461	0.24
BC546	0.10
BC547	0.11
BC547A	0.11
BC547B	0.11
BC547C	0.11
BC548A	0.11
BC548B	0.11
BC548C	0.11
BC549A	0.11
BC549B	0.11
BC550	0.11
BC557	0.11
BC557A	0.11
BC557B	0.11
BC557C	0.11
BC558	0.11
BC558A	0.11
BC558B	0.11
BC559B	0.11
BCY42	0.55
BCY58	0.20
BCY71	0.13
BCY72	0.13
BD115	0.30
BD116	0.30
BD123	0.60
BD128	1.02
BD131	0.35
BD133	0.40
BD135	0.30
BD136	0.30
BD137	0.30
BD138	0.30
BD139	0.30
BD140	0.30
BD144	0.30
BD168	0.50
BD178	0.72
BD181	1.32
BD183	1.50
BD232	0.60
BD233	0.60
BD234	0.60
BD235	0.40
BD236	0.40
BD237	0.40
BD238	0.40
BD434	0.40
BD507	0.50

BD508	0.50
BD518	0.50
BD537	1.02
BD587	1.40
BDX32	1.90
BDY16	0.50
BDY20	0.50
BF115	0.35
BF121	0.20
BF123	0.20
BF125	0.20
BF127	0.20
BF137	0.21
BF152	0.15
BF154	0.15
BF157	0.37
BF158	0.15
BF167	0.25
BF173	0.20
BF174	0.20
BF177	0.25
BF178	0.25
BF179	0.25
BF180	0.20
BF181	0.20
BF182	0.20
BF183	0.20
BF184	0.20
BF185	0.20
BF194	0.06
BF194A	0.07
BF195	0.06
BF195D	0.07
BF195G	0.07
BF196	0.06
BF197	0.06
BF198	0.06
BF224	0.18
BF253	0.18
BF254	0.18
BF255	0.18
BF257	0.16
BF258	0.28
BF259	0.28
BF324	0.20
BF335	0.25
BF338	0.45
BF457	0.60
BF523	0.22
BF594	0.10
BFR91	5.00
BFT43	0.54
BFX29	0.20

BFX43	0.70
BFX84	0.20
BFX85	0.20
BFX88	0.20
BFY18	0.50
BFY19	0.50
BFY33	0.50
BFY34	0.50
BFY46	0.50
BFY51	0.12
BFY52	0.12
BFY81	4.00
BRY39	0.35
BSX20	0.18
BSX52	0.33
BSY20	0.21
BSY25	0.30
BSY26	0.30
BSY27	0.30
BSY29	0.54
BSY39	0.15
BSY52	0.33
BSY54	0.39
BSY56	0.36
BSY60	0.36
BSY84	0.30
BU105	1.08
BU105-04	1.08
BU108	1.80
BU126	1.00
BU133	1.75
BU204	1.30
BU205	1.30
BU208	1.50
BU208-02	1.75
BU406	3.60
BUY69A	6.75
BUY69B	2.00
BUY69C	7.00
BUY70A	5.00
BUY71	4.50
MPS6517	0.48
MPS6523	0.27
MPSA06	0.90
MV5053	0.72
NKT214	0.25
NKT224	0.25
OC22	1.40
OC26	1.40
OC29	0.85
OC36	1.00
OC44	0.12
OC45	0.12

OC71	0.09
OC74	0.10
OC75	0.10
OC82	0.48
OC139	0.50
OC203	2.50
OC207	2.70
OC1072	2.50
OC1074	2.50
R2008B	2.10
TIP30	0.35
TIP31	0.45
TIP31A	0.45
TIP32	0.45
TIP33	0.60
TIP42	0.60
TIP2955	0.65
TIS90	0.18
2N344B	0.30
2N404	0.45
2N524	0.48
2N526	0.48
2N527	0.48
2N685	3.50
2N705	0.10
2N706	0.10
2N706A	0.11
2N708	0.12
2N1039	0.15
2N1059	0.15
2N1101	0.15
2N1102	0.15
2N1132	0.20
2N1304	0.50
2N1305	0.50
2N1307	0.50
2N1309	0.50
2N1613	0.18
2N1671	1.10
2N1671B	2.20
2N1711	0.20
2N1893	0.25
2N1905	0.25
2N1990	0.25
2N2060	1.00

2N2188	0.20
2N2218A	0.22
2N2222	0.18
2N2222A	0.20
2N2270	0.39
2N2368	0.10
2N2484	0.18
2N2904	0.18
2N2906	0.18
2N3053	0.15
2N3117	1.00
2N3440	0.70
2N3638	0.15
2N3638A	0.16
2N3643	0.24
2N3692	0.24
2N3705	0.06
2N3706	0.06
2N3707	0.06
2N3711	0.06
2N3819	0.20
2N3899	3.00
2N3904	0.06
2N3905	0.06
2N3906	0.06
2N4037	0.25
2N4058	0.10
2N4222A	0.65
2N4348	2.00
2N4448	1.50
2N4914	3.50
2N5172	0.25
2N5245	0.30
2N5296	0.40
2N5458	0.25
2N5496	0.60
2N5670	0.65
2N5926	0.55
2N6123	0.65
2S003	0.75
2S303	0.90
2S304	0.90
2S305	0.90
2S323	1.00
2S732	1.00

TTL

7400	.12	7476	.13	74161	.80
7401	.12	7483	.75	74163	.80
7402	.12	7484	.90	74164	.90
7403	.12	7485	.90	74165	.90
7404	.13	7486	.26	74166	1.00
7405	.13	7489	2.00	74167	2.70
7406	.29	7490	.35	74170	1.70
7407	.29	7491	.65	74172	4.00
7408	.14	7492	.45	74173	1.20
7409	.14	7493	.36	74174	.90
7410	.13	7494	.80	74175	.70
7411	.18	7495	.55	74176	.90
7412	.21	7496	.62	74177	.90
7413	.25	7497	2.40	74178	1.20
7414	.54	74100	.95	74179	1.10
7416	.27	74105	.40	74180	.70
7417	.27	74107	.28	74181	1.95
7420	.13	74109	.45	74182	.75
7421	.28	74110	.46	74184	1.20
7423	.25	74111	.70	74185	1.20
7425	.22	74116	1.60	74186	7.20
7426	.25	74118	.82	74188	5.40
7427	.25	74119	1.30	74190	1.10
7428	.34	74120	.82	74191	1.00
7430	.13	74121	.26	74192	1.00
7432	.24	74122	.40	74193	1.10
7433	.32	74123	.55	74194	.92
7437	.24	74125	.45	74195	.85
7438	.24	74126	.46	74196	.92
7440	.13	74128	.62	74197	.92
7441	.52	74132	.70	74198	1.60
7442	.55	74141	.58	74199	1.50
7444	.90	74142	2.02		
7445	.70	74143	2.02		
7446	.70	74144	2.02		
7447	.66	74145	.65		
7448	.60	74147	1.35		
7450	.13	74148	1.20		
7451	.13	74150	1.00		
7452	.13	74151	.60		
7454	.13	74153	.60		
7460	.13	74154	1.06		
7470	.28	74155	.63		
7472	.22	74156	.63		
7473	.26	74157	.63		
7474	.20	74158	1.70		
7475	.28	74160	.80		

CMOS

4000	.15	4073	.20
4001	.15	4075	.20
4002	.20	4076	1.10
4006	.95	4078	.20
4007	.20	4081	.20
4008	.94	4082	.20
4009	.46	4502	.90
4010	.50	4507	.52
4011	.15	4508	2.30
4012	.15	4510	1.10
4013	.35	4511	.70
4014	.85	4512	.95
4015	.80	4516	.70
4016	.45	4518	.65
4017	.55	4520	1.10
4018	.90		
4019	.45		
4020	.60		
4021	.85		
4022	.85		
4023	.20		
4024	.68		
4025	.20		
4026	1.35		
4027	.35		
4028	.70		
4029	.90		
4030	.50		
4033	1.40		
4035	1.10		
4040	.90		
4041	.80		
4042	.75		
4043	.85		
4044	.85		
4049	.28		
4050	.45		
4051	.88		
4052	.88		
4053	.88		
4055	1.00		
4060	1.00		
4066	.35		
4068	.20		
4069	.20		
4070	.20		
4072	.20		

DIODES

AA119	0.17	BB105G	0.36	BY201-3	0.40	ITT210	1.35	OA202	0.07
AA121	0.11	BB110G	0.46	BY201-4	0.45	ITT827	2.35	ST2	0.14
AA129	0.08	BB142	1.25	BY201-5	0.55	ITT921	0.20	1N4001	0.04
AA143	0.15	BR100	0.20	BY201-6	0.56	ITT923	0.36	1N4002	0.05
AA144	0.09	BR101	0.30	BY203-12	0.60	ITT1075	0.25	1N4003	0.05
BA102	0.30	BY100	0.20	BY203-16	0.65	ITT2001	0.25	1N4004	0.06
BA111	0.98	BY103	0.35	BY203-20	1.00	ITT2002	0.20	1N4005	0.06
BA115	0.25	BY118	1.45	BY204-4	0.45	MR502	0.75	1N4006	0.07
BA145	0.15	BY126	0.15	BY204-8	0.65	MR813	0.90	1N4007	0.08
BA148	0.12	BY127	0.10	BY204-10	0.75	MR854	1.80	1N4148	0.04
BA154	0.10	BY130	0.15	BY206	0.30	MR856	2.10	1N4150	0.45
BA155	0.12	BY133	0.10	BY210-400	0.45	MR992A	1.56	1N4448	0.25
BA156	0.12	BY134	0.45	BY210-600	0.50	MV2203	1.80	1N5401	0.12
BA157	0.46	BY142	0.46	BY210-800	0.55	MV5460	0.6L	1N5402	0.15
BA158	0.65	BY164	0.50	BYX10	0.35	OA47	0.07	1N5403	0.15
BA159	0.75	BY176	3.45	BYX55-350	0.45	OA70	0.07	1N5404	0.16
BA182	0.46	BY179	0.90	BYX55-600	0.55	OA71	0.35	1N5405	0.26
BA201	0.15	BY182	1.85	BYX71-350	0.90	OA81	0.12	1N5406	0.20
BA243	0.85	BY184	0.70	BYX71-600	1.15	OA85	0.12	1N5407	0.19
BAX13	0.06	BY187	1.30	BZX61 series	0.18	OA86	0.20	1N5408	0.20
BAX16	0.07	BY198	0.75	BZY88 series	0.08	OA90	0.07	1N5450A	6.75
BAX17	0.10	BY199	0.55	OK13	0.45	OA91	0.06	1N5761	0.60
BB105B	0.36	BY201-2	0.40	ITT44	0.10	OA95	0.06		

LINEAR INTEGRATED CIRCUITS

CA3020	1.75	SC9504P	2.00	TAA300	3.76	TBA400	2.25	TBA750Q	2.50
CA3046	0.80	SL414A	4.86	TAA310	3.15	TBA510	2.40	TBA800	0.90
CA3048	2.50	SL415A	6.30	TAA320	2.60	TBA510Q	2.50	TBA800Q	2.85
CA3065	1.58	SL901B	8.50	TAA350A	3.00	TBA520	2.50	TBA810A	3.40
CA3089E	7.88	SL917B	10.70	TAA435	3.40	TBA520Q	2.50	TBA810S	1.10
CA3090Q	4.50	SL1310	5.66	TAA550	0.60	TBA530	2.50	TBA820	0.80
ETT6016	4.96	SL1327	2.75	TAA550B	0.40	TBA530Q	2.50	TBA915	7.35
ETTR6016	4.96	SL3046	2.60	TAA570	2.85	TBA540	2.50	TBA920	3.00
MC1303L	1.50	SN76003N	2.50	TAA621	6.96	TBA540Q	2.25	TBA920Q	3.60
MC1304P	2.00	SN76003ND	2.15	TAA630	8.56	TBA550	3.50	TBA950-2	5.40
MC1306	6.15	SN76013N	1.50	TAA630S	6.10	TBA550Q	3.80	TBA950-2X	5.04
MC1307P	2.85	SN70613NO	2.15	TAA661A	1.70	TBA560	6.46	TBA990	4.96
MC1310P	1.00	SN76023N	1.50	TAA661B	1.80	TBA560C	4.60	TBA990Q	3.76
MC1327P	2.75	SN76023ND	2.15	TAA700	3.50	TBA560Q	7.35	TCA160	6.10
MC1327PQ	2.50	SN76033N	2.40	TAA840	4.50	TBA560CQ	3.00	TCA270	3.00
MC1330P	1.25	SN76110N	1.50	TAD100	1.36	TBA570	2.00	TCA270B	3.80
MC1339P	3.96	SN76131N	2.00	TBA120A	3.06	TBA570Q	2.00	TCA270Q	3.60
MC1349	3.36	SN76226N	3.15	TBA120AS	1.60	TBA641A12	6.20	TCA270S	2.25
MC1351P	1.26	SN76226ND	3.16	TBA120S	2.70	TBA641B11	5.65	TCA270SQ	3.40
MC1352P	1.45	SN76227N	2.50	TBA120SB	1.60	TBA673	5.00	TCA800	6.40
MC1358PQ	3.86	SN76532N	3.15	TBA120SQ	1.60	TBA700	3.96	TCA800Q	12.40
SAA570	4.20	SN76533N	2.70	TBA281	4.70	TBA700Q	2.25	TCA830	3.10
SAA700B	10.15	SN76544N	1.80	TBA350A	3.00	TBA720	5.10	TDA440	6.75
SAS560	2.76	SN76550N	1.80	TBA396	1.80	TBA720A	5.10	TDA1327	2.85
SAS570	2.75	SN76660N	0.80	TBA440	3.60	TBA720AQ	2.10	TDA1327B	2.85
SBA750B	6.75	SN76666N	1.60	TBA440S	3.96	TBA750	2.40	TDA1330	1.60
SC9503P	2.00			TBA480Q	2.50			741	0.25

BRIDGE RECTIFIERS

CURRENT	VOLTAGE	ORDER CODE	PRICE
1A	50V	B1/50	0.26
1A	100V	B1/100	0.26
1A	200V	B1/200	0.28
1A	400V	B1/400	0.30
1A	800V	B1/800	0.34
2A	50V	B2/50	0.40
2A	100V	B2/100	0.46
2A	200V	B2/200	0.56
2A	400V	B2/400	0.66
2A	800V	B2/800	0.70
3A	200V	B3/200	0.70
3A	600V	B3/600	0.80
4A	100V	B4/100	0.90
4A	400V	B4/400	0.96
6A	50V	B6/50	0.96
6A	200V	B6/200	1.10
6A	400V	B6/400	1.20
10A	400V	B10/400	2.60
25A	50V	B25/50	4.00
25A	200V	B25/200	4.20
25A	400V	B25/400	4.30

I. C. SOCKETS

NO. OF PINS	ORDER CODE	PRICE
8	D8	0.10
14	D14	0.11
16	D16	0.13
20	D20	0.30
22	D22	0.35
24	D24	0.40
28	D28	0.45
40	D40	0.60

PANEL METERS

Size 2" x 2" x 1 3/8", requires 1¾ cut-out.

F.S.D.	ORDER CODE	PRICE
1mA	M1	5.50
500mA	M500	5.50

THYRISTORS

CURRENT	VOLTAGE	CASE	ORDER CODE	PRICE
80mA	30V	TO18	SO8/30	0.22
80mA	60V	TO18	SO8/60	0.24
80mA	200V	TO18	SO8/200	0.26
1A	50V	TO220	S1/50	0.25
1A	100V	TO220	S1/100	0.26
1A	200V	TO220	S1/200	0.28
1A	400V	TO220	S1/400	0.35
3A	50V	TO220	S3/50	0.25
3A	100V	TO220	S3/100	0.28
3A	200V	TO220	S3/200	0.30
3A	400V	TO220	S3/400	0.40
4A	50V	TO220	S4/50	0.35
4A	100V	TO220	S4/100	0.40
4A	200V	TO220	S4/200	0.50
4A	400V	TO220	S4/400	0.56
5A	400V	TO220	S5/400	0.56
7A	50V	TO220	S7/50	0.46
7A	100V	TO220	S7/100	0.50
7A	200V	TO220	S7/200	0.56
7A	400V	TO220	S7/400	0.80
8A	400V	TO220	S8/400	0.70

TRIACS

CURRENT	VOLTAGE	CASE	ORDER CODE	PRICE
3A	100V	TO220	T3/100	0.75
3A	200V	TO220	T3/200	0.80
3A	400V	TO220	T3/400	0.86
6A	200V	TO220	T6/200	1.00
6A	400V	TO220	T6/400	1.06
8A	400V	TO220	T8/400	1.36
10A	400V	TO220	T10/400	1.40
15A	400V	TO220	T15/400	2.00

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RESISTORS

¼W Values available in E12 series from 10R to 1M. Price 0.03 each.
½W Values available in E 12 series from 1R0 to 10M. Price 0.03 each.
1W Values available in E12 series from 2R2 to 10M. Price 0.06 each.
2W Values available in E12 series from 10R to 10M. Price 0.11 each.
5W Values available in E6 series from 1R0 to 6K8.
Prices 1R0 to 1K0 0.19 each.
1K5 to 3K3 0.22 each.
4K7 to 6K8 0.24 each.
7W Values available in E12 series from R47 to 22K.
Prices R47 to R82 0.25 each.
1R0 to 1K0 0.26 each.
1K2 to 12K 0.27 each.
15K to 22K 0.28 each.
11W Values available in E6 series from 1R0 to 22K.
Prices 1R0 to 1K0 0.28 each.
1K5 to 12K 0.30 each.
15K to 22K 0.36 each.
17W Values available in E6 series from 1R0 to 22K
Prices 1R0 to 4K7 0.39 each.
6K8 to 22K 0.41 each.

½W Single turn cermet potentiometer. Values available 100R, 200R, 500R, 1K0, 2K0, 5K0, 10K, 20K, 50K, 100K, 200K, 500K, 1M
Price 0.97 each.

¾W Multiturn cermet potentiometer. Values available 20R, 50R, 100R, 200R, 500R, 1K0 2K0, 5K0, 10K, 20K, 100K, 500K.
Price 1.40 each.

1W Potentiometer with 2" spindle. Values available 10R, 25R, 50R, 100R, 250R, 500R, 1K0, 2K5, 5K0, 10K, 20K
Prices 10R to 5K0 1.61 each.
10K & 20K 1.62 each.

1.5W Convergence preset potentiometer. Values available 5R0, 7R0, 10R, 15R, 20R, 100R, 500R.
Price 0.60 each.

2W 10 Turn potentiometer. Values available 100R, 200R, 500R, 1K0, 2K0, 5K0, 10K, 20K, 50K, 100K.
Price 7.34 each.

CAPACITORS

Tantalum Bead

6.3V	47uF	0.32 each
	100uF	0.50 each
16V	10uF	0.24 each
	22uF	0.30 each
	47uF	0.50 each
25V	22uF	0.41 each
35V	0.1uF	0.22 each
	0.22uF	0.22 each
	0.47uF	0.22 each
	1.0uF	0.22 each
	2.2uF	0.22 each
	4.7uF	0.24 each

Disc Ceramic

8kV	150pF	0.27 each
	180pF	0.27 each
	200pF	0.27 each
	220pF	0.27 each
	250pF	0.40 each
	270pF	0.40 each
	300pF	0.40 each

Mixed Dielectric

600V	1uF	1.01 each
1kV	0.01uF	0.26 each
	0.033uF	0.32 each
	0.047uF	0.35 each
	0.1uF	0.39 each
	0.22uF	0.58 each
	0.47uF	0.89 each
1.25kV	0.1uF	0.50 each
1.5kV	0.001uF	0.24 each
	0.0022uF	0.24 each
	0.0047uF	0.24 each
	0.22uF	0.28 each

Single Ended Electrolytic

16V	10uF	0.11 each
	22uF	0.11 each
	47uF	0.11 each
	100uF	0.11 each
	220uF	0.14 each
	470uF	0.28 each
	1000uF	0.32 each
63V	1uF	0.11 each
	2.2uF	0.11 each
	4.7uF	0.11 each
	10uF	0.13 each
	22uF	0.16 each
	47uF	0.22 each
	100uF	0.32 each
	220uF	0.46 each

Double Ended Electrolytic

10V	22uF	0.14 each
	100uF	0.14 each
	220uF	0.17 each
	470uF	0.36 each
	1000uF	0.40 each

25V	10uF	0.14 each
	22uF	0.14 each
	47uF	0.17 each
	100uF	0.17 each
	220uF	0.36 each
	470uF	0.47 each
	1000uF	0.72 each
63V	1uF	0.14 each
	2.2uF	0.14 each
	4.7uF	0.14 each
	10uF	0.17 each
	22uF	0.17 each
	47uF	0.29 each
	100uF	0.40 each
	220uF	0.65 each
	470uF	0.66 each
	1000uF	1.01 each
	2200uF	1.44 each
100V	10uF	0.20 each
	22uF	0.25 each
	47uF	0.36 each
	100uF	0.61 each
	220uF	0.68 each
450V	1uF	0.27 each
	4.7uF	0.45 each
	10uF	0.53 each
	22uF	1.07 each
	33uF	1.22 each

Silvered Mica

500V	3.3pF	0.18 each
	5pF	0.18 each
	10pF	0.18 each
	39pF	0.18 each
	100pF	0.18 each
	150pF	0.18 each
	180pF	0.18 each
	220pF	0.18 each
	330pF	0.36 each
	470pF	0.36 each
	680pF	0.36 each
	820pF	0.36 each
	1000pF	0.42 each
	2200pF	0.50 each
	8200pF	1.58 each
	10000pF	1.62 each

Multi-sectional Electrolytic

30V	2500/2500uF	1.94 each
70V	2500/2500uF	2.70 each
300V	150/150/100uF	2.81 each
350V	200/300uF	2.46 each
	200/200/100/32uF	3.89 each
	150/100/100/100/150uF	4.75 each
	400/400uF	4.75 each
	300/300/150/100/50uF	5.18 each

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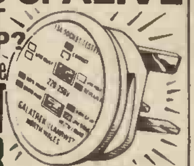

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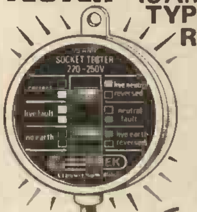

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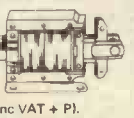

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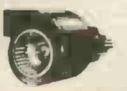

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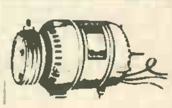

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LONDON WC2H 7JJ
Phone 01-437 0576

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